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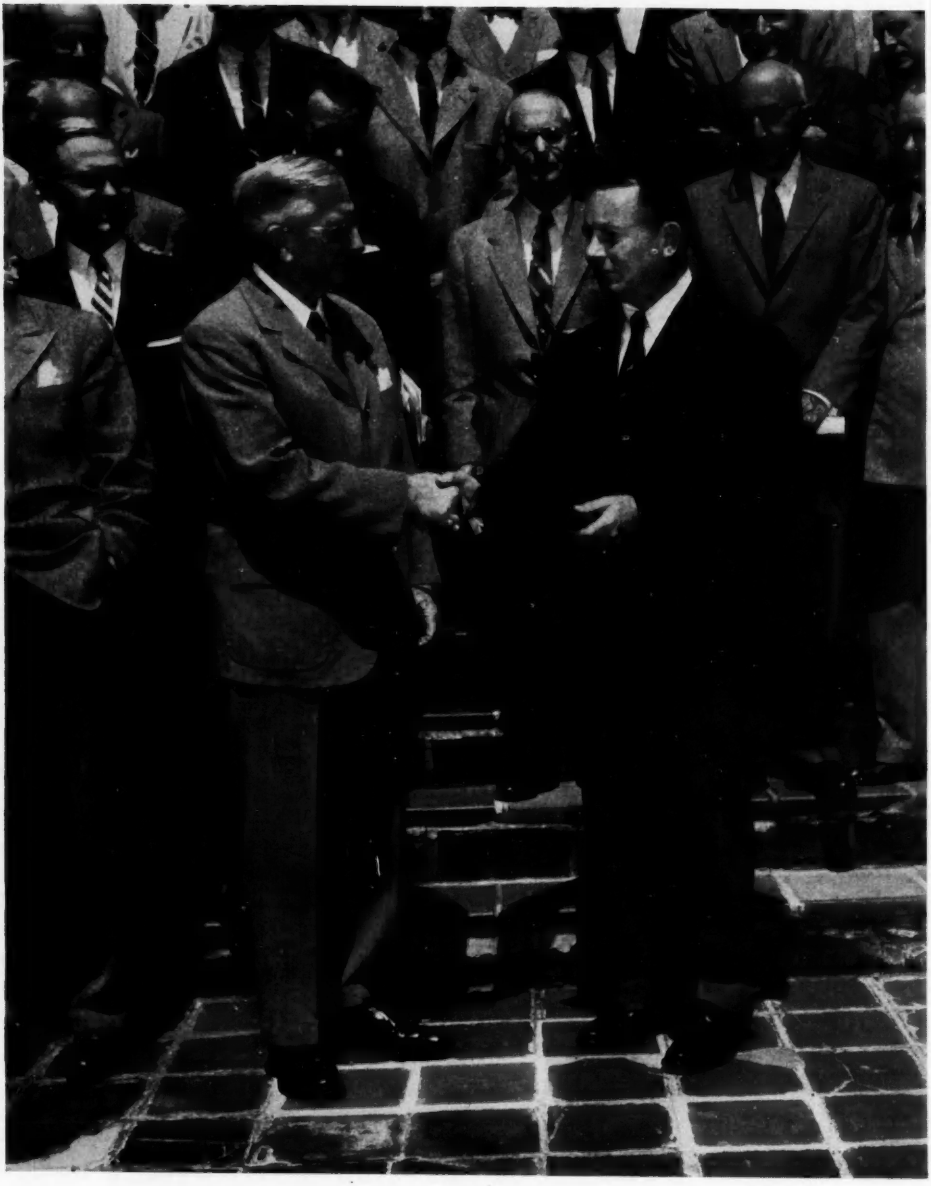

PRESENTATION OF BARRINGER MEDAL TO DR. GEORGE FRANCIS CAHILL

DR. GEORGE W. FISH (New York, N. Y.): We are gathered here to confer upon one of our members an award for his outstanding contributions to urological surgery.

George Francis Cahill, you were given a splendid background by your distinguished teachers in general and urological surgery, the value of which you realized from the beginning of your career. You have made a clinical and surgical contribution on diseases of the adrenal gland, which is recognized throughout the world. This, you have done not by pure creation but by steadfastness of purpose and never-lagging interest. The knowledge that you have acquired in this work, you have been ever generous in sharing with your colleagues.

You have given to the specialty of urology to have and to hold as its own, if it so desires, the surgery of the adrenal glands.

The Barringer Medal was struck off and given to this society by the family of our beloved fellow member, Benjamin Barringer, one of your first teachers. The Barringer family requested that our society, in its wisdom, award this medal from time to time for outstanding achievement in the field of urology. The medal has been awarded only once before, to our brilliant colleague, Dr. Charles Huggins.

George Francis Cahill, your peers have found you worthy through your deeds to possess the Barringer Medal, one of the highest honors they can bestow upon you.

May I express my appreciation to the members of the society for having chosen me to present to you, my fellow worker through these many years, this medal.

DR. GEORGE FRANCIS CAHILL: One can't help but be somewhat overwhelmed with sentiment on an occasion like this, particularly because my first introduction to urology was as an intern at Bellevue Hospital.

The department to which I was assigned was headed by Dr. Chatwick, a cousin of our esteemed Edwin Keyes, whom very few people knew because of clashing personalities between the two. The next was J. Bayard Clark, and just above me was Benjamin Barringer. One of the troublesome things he had to do was try to beat a little urology into my head long years back, and to think that time should go around the circle and I should wind up receiving Ben Barringer's medal!

I want to thank the members of the committee who thought of me: John Taylor, my colleague and friend of long standing; Doctor Fish, for making such a fine tribute; and all of you gentlemen. Thank you.

A PHYSIOLOGICAL APPROACH TO BLADDER IRRIGATION IN GROSS HEMATURIA

J. U. SCHLEGEL, HANS JØRGENSEN,* A. McFADDEN AND W. W. SCOTT

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The occurrence of frank bleeding from the urinary tract can create a problem in management, since clot formation may block an indwelling catheter or even a normal urethra. It seems reasonable to state that it is the desire of the surgeon to maintain an outflow of urine, not only to avoid azotemia but also for a continuous evaluation of the severity of the bleeding. Following prostatectomies, gross hematuria to a more or lesser extent is quite common. It is consequently a frequent postoperative procedure to use continuous or frequent bladder irrigations to maintain the patency of indwelling catheters by diluting the blood sufficiently to avoid clotting. The disadvantages with such procedures are several. There is always the danger of inducing an infection, accurate urine volume is hard to estimate due to the presence of a large amount of irrigation fluid, and frequent attendance to maintain the patency of the catheter or catheters is often required. From a practical point of view, many of these disadvantages could be overcome if a diuresis of sufficient volume could be established to maintain an internal irrigation. It is, however, well known that attempts to hydrate patients following surgery, as well as during conditions involving pain, hemorrhage, and emotional disturbances, will result in over-hydration with retention of fluids, due to antidiuresis.[1-7] The antidiuresis present in such cases is supposedly a result of a stimulation of the posterior pituitary; not by virtue of an increase in serum osmolality, but apparently due to a neurogenic stimulation, the nature of which is uncertain. Antidiuresis, however, does not mean that urine volume necessarily has to be low. It merely implies that the ratio of solute to water in the urine is increased, so that the concentration of solutes in the urine is higher than in the serum.

This investigation was supported with funds from the Adeline Ritter Shumway Fund and from the Office of Naval Research.

We wish to express our sincere appreciation for the co-operation rendered by the Abbott Laboratories, North Chicago, Illinois, which has generously supplied us with the lyophilized urea used in this study. We also wish to express our sincere thanks to the nurses who have taken care of the patients in the metabolism room.

* Fulbright Fellow in Urology Research.

[1] Dudley, H. F., Boling, E. A., LeQuesne, L. P. and Moore, F. D.: Studies on antidiuresis in surgery: Effects of anesthesia, surgery and posterior pituitary antidiuretic hormone on water metabolism in man. Ann. Surg., **140:** 354, 1954.

[2] LeQuesne, L. P. and Lewis, A. A. G.: Postoperative retention of water and sodium. The kidney. Ciba Foundation Symposium, p. 193, 1954.

[3] Kerrigan, G. A., Talbot, N. B. and Crawford, J. D.: Role of the neurohypophyseal-antidiuretic-hormone-renal system in everyday clinical medicine. J. Clin. Endocrin., **15:** 265, 1955.

[4] Leaf, A. and Mamby, A. R.: An antidiuretic mechanism not regulated by extracellular fluid tonicity. J. Clin. Invest., **31:** 60, 1952.

[5] Smith, H. W.: Renal excretion of sodium and water. Fed. Proc., **11:** 701, 1952.

[6] Wangensteen, O. H. and Zimmerman, B.: Observations on water intoxication in surgical patients. Surgery, **31:** 654, 1952.

[7] Ariel, I. M., Kremen, A. J. and Wangensteen, O. H.: An expanded interstitial (thiocyanate) space in surgical patients. Surgery, **27:** 827, 1950.

Forcing water containing no solutes other than dextrose will obviously lead to a disturbance of the homeostasis with dilution of the serum electrolytes. The presence of glucose in the infusion is, in this respect, of no value, since it is metabolized to CO_2 and water.

Salt must naturally be considered a solute, but, since sodium retention often prevails following surgery, due to active reabsorption possibly in the proximal tubule of the kidney, it is consequently not available quantitatively for excretion in the urine. Therefore, the postoperative administration of large amounts of fluids containing salt would not lead to any dilution of body fluids but to an expansion, which again implies that the urine volume would remain low and that the patient would become edematous. It is well known that during antidiuresis the urine volume is a direct result of the amount of solutes excreted.[1, 8] One solute which apparently is handled rather passively by the kidney and which will be distributed evenly over total body water, thus not causing any change in the compartmental distribution, is urea. It has been shown by us that antidiuresis following surgery can be completely overcome by the administration of urea as a 4 per cent solution.[9] Its addition to infusion solutions of 5 per cent dextrose in water given patients with relatively normal kidney function will not lead to dehyration and will maintain homeostasis in regard to water and electrolytes. In meeting the obligatory requirement of the kidney during antidiuresis, it is important to realize that it is not the volume given that is of particular significance, but the ratio of solute to water which has to be adjusted to the immediate functional capacity of the kidney. This, in reality, means that it is feasible to give large amounts of fluid, provided that it contains the proper amount and kind of solute, and thus obtain a urine output which can be adjusted at will to suit the purpose for which it is intended. A more thorough study of the basic mechanism involved has been published elsewhere.[9] In this paper, a practical utilization of the basic physiological phenomenon of post-traumatic antidiuresis is presented as it occurs following suprapubic prostatectomies.

MATERIAL AND METHODS

Forty prostatectomy cases were used in this study. All the patients had at time of surgery a phenolsulfonphthalein within normal limits and a nonprotein nitrogen and blood urea nitrogen likewise within normal limits. Some of the patients also had urea clearances which varied between 50 and 100 per cent of normal: a few of these had decreased kidney function when first seen; none of them had frank renal insufficiency at time of surgery.

The majority of the patients were followed in a room with constant temperature and humidity; they were on a diet of known composition, and accurate records were kept of their intake and output. Serum and urine chemistries were determined daily, and total balance studies in regard to nitrogen, sodium, potassium and water were carried out on a 24-hour basis. The patients were weighed once a day. This study deals only with the first 24-hour period following

[8] Brodsky, W. A.: IV. Determination of water and electrolyte excretion during osmotic diuresis in hydropenic man. Meth. Med. Res., **5**: 192, 1952.

[9] Schlegel, J. U., Eldrup-Jørgensen, S. and Stone, H.: Studies in metabolism of trauma: I. Maintenance of homeostasis during antidiuresis. Ann. Surg., **145**: 12, 1957.

surgery, and the weights recorded are those obtained immediately prior to surgery and 24 hours following. A few patients were followed as controls and received approximately 2000 cc 5 per cent dextrose in water intravenously in the first 24-hour period following surgery. The other patients received 4 per cent urea added to infusion solutions of 5 per cent dextrose in water; the majority of the patients received 4000 cc intravenously in the first 24-hour period, and a few received only 3000 cc. In order to evaluate the balances more accurately and avoid dilution of the administered solutes, the patients were all kept on no oral intake for the first 24 hours following surgery. The methods used for determination of serum and urine chemistries have been published elsewhere.[9]

Urea was in all instances given in isotonic solutions of glucose (or saline) since even isotonic solutions of urea in water (1.8 per cent) can cause hemolysis.[10]

The intravenous fluids containing urea were prepared by using lyophilized urea which was dissolved in the infusion solution immediately prior to the administration. Prepared in this way, it is stable for at least a 24-hour period. It is necessary, however, to keep the urea in lyophilized, dry form until such time that it can be used, since otherwise it will absorb water and decompose, forming ammonia. Heat rapidly decomposes urea with the formation of ammonia, and consequently solutions containing urea can not be autoclaved. The lyophilized preparation that we have used has been kindly made available to us through the co-operation of the Abbot Laboratories.

RESULTS

None of the patients receiving urea added to the infusion solutions had any untoward effects; all had an excellent output and did not require catheter irrigation since clotting was prevented by their high urinary output. Seven of the 40 patients had primary closure of the bladder. All seven received approximately 4000 cc intravenous fluids with 4 per cent urea, and no complications due to bleeding were encountered. All 40 patients did quite well; there were no fatalities, and no significant clinical difference between the patients who received urea and the few who did not receive urea added to the infusion solutions but only received 2000 cc intravenous fluids.

In table 1 are given some of the data obtained from some of the patients receiving approximately 4000 cc intravenously and 3000 cc intravenously, respectively. It will be noticed that there was no significant difference in the percentage return of the administered fluids nor in the percentage return of the administered urea. Sodium balance varied considerably from individual to individual but was negative in most instances. Although there were minor deviations in the serum sodium and serum osmolarity, the over-all changes were extremely small and, in general, it can be stated that no changes in serum electrolytes took place even with fluid loads as high as 4000 cc, if 4 per cent urea was added to the infusion solutions of 5 per cent dextrose in water. Increases in blood urea nitrogen were naturally observed but, as previously stated, this had no un-

[10] Javid, M. and Settlage, P.: Effect of urea on cerebrospinal fluid pressure in human subjects. A preliminary report. J.A.M.A., **160**: 943, 1956.

TABLE 1. *Patients receiving 5 per cent dextrose infusions with 4 per cent urea*

Subject	Intake H_2O cc	Urine Per cent of Intake	Urea Excreted Per cent of Intake	Na Balance mEq.	Serum Na Per cent Change	Serum Osmolarity (Corrected Per cent Change)	BUN Change mg%	Weight Change Grams
a. (appr. 4000 cc Intake)								
E. C.	4000	102.0	73.6	−126	−2.1	−1.4	+56.3	−500
H. D.	4000	92.7	54.0	−97	−2.1	−0.7	+34.7	−1100
C. H.	3845	95.3	69.7	−29	−0.2	+1.5	+26.3	−800
G. E.	4210	86.2	56.2	−24	+2.5	+6.0	+65.5	−900
R. L.	4004	100.0	72.4	−118	−1.6	−0.3	+41.7	−1350
H. F.	4000	81.5	46.5	+55	−0.4	+2.5	+68.9	−1650
A. L.	4000	93.2	71.5	−108	−1.8	−1.1	+48.7	−1750
C. S.	4100	72.1	36.7	−9	+3.6	+1.0	+61.3	−1400
P. M.	4000	83.1	56.3	−37	−1.7	+1.4	+60.5	−1150
H. F.	4000	93.8	54.5	+29	+4.0	+4.2	+35.3	−1900
Mean	4016	90.0	59.1	−46.4	+0.2	+1.3	+49.9	−1250
b. (appr. 3000 cc Intake)								
C. W.	2750	87.3	57.3	+15	+2.4	−1.4	+48.5	−450
H. H.	2590	93.6	52.4	−51	−3.2	−1.4	+61.3	−500
I. L.	3350	103.0	65.1	−18	−0.3	+2.2	+39.2	−1400
H. W.	3300	87.1	66.2	−6	−2.6	−6.1	+50.1	−950
J. A.	3000	77.4	49.6	+13	+1.1	+2.1	+44.8	−550
Mean	2998	89.7	58.1	−9.4	−0.5	−0.9	+48.8	−770

toward effect and usually declined very rapidly throughout the next two or three days. The weight losses were significantly higher than those obtained in the control patients not receiving urea, and were more equivalent to the weight loss observed in normal individuals on nothing by mouth and on bed rest for 24-hour periods.[9] It thus appears that the administration of high fluid loads containing 4 per cent urea, on the day of surgery, is a perfectly safe and harmless procedure which will not lead to any water intoxication in patients with relatively normal kidney function.

In table 2 are presented the results obtained in 8 patients receiving an average of 2200 cc of 5 per cent dextrose in water, and it will be noted that the percentage volume return was considerably lower than in the patients receiving even the double amount but with 4 per cent urea. The sodium balance in these cases is negative, as in most of those receiving 4 per cent urea, but in general exceeds the negativity in the cases receiving urea. However, this does not appear significant and in general one might state that the addition of urea to the infusion solutions, even when large amounts of fluid are given, does not significantly alter the sodium metabolism. In the control cases, it will be seen that a slight dilution did occur with a change in sodium and osmolarity indicative of a slight degree of water

TABLE 2. *Patients receiving 5 per cent dextrose infusions not containing urea*

Subject	Intake H_2O cc	Urine Per cent of Intake	Na Balance mEq.	Serum Na Per cent Change	Serum Osmolarity (Corrected) Per cent Change	Weight Change Grams
W. M.....	2060	21.9	−24	−3.5	−3.2	−400
E. L.....	2060	47.9	−78	−5.6	−5.4	+400
D. V.....	2250	40.4	−116	−3.2	−3.1	−1000
E. V.....	2080	42.8	−102	−2.4	−4.5	−1500
C. G.....	2190	49.9	−71	−3.8	−4.3	−400
W. L.....	2559	25.9	−39	−4.2	−3.9	−300
W. S.....	2665	84.7	−86	−0.8	−2.1	−550
J. C.....	2090	35.6	−57	−1.6	−3.8	−650
Mean.....	2244	43.6	−72	−3.1	−3.8	−550

intoxication. Parallel to this is seen a weight change which, although negative, is less so than in the patients receiving the 4 per cent urea infusion solutions.

From these results, it appears that up to 4000 cc of 5 per cent dextrose in water containing 4 per cent urea can safely be given to patients on the day of surgery, provided that their kidney function is relatively normal. This also applies to cardiac patients, of whom there were several included in this study. The reason for this is that urea is rapidly distributed over total body water and will thus not lead to any shift in the compartmental distribution of fluid, especially to no increase in circulating blood volume. The usual contraindication for rapid administration of intravenous fluids to cardiac patients must naturally still be borne in mind.

Larger amounts of sodium should not be given, since this will be retained; however, a slight negative sodium balance will occur unless an amount of approximately 5 grams of sodium chloride is administered. Practically no sodium loss occurs, following surgery, in patients who, beforehand, have been on a low sodium diet or who have sodium retention for other reasons; therefore no sodium should be given such patients postoperatively.

DISCUSSION

The main purpose of this work is to show the practical application of a physiologically well established fact. The average weight loss as reported by other authors following surgery is considerably less than the weight loss which will be encountered in normal individuals who are receiving no food for a period of 24 hours, and who are on bed rest and receiving intravenous fluids only.[9, 11, 12] The weight losses that we find in patients who have received 4 per cent urea added to their intravenous fluids are more identical with what appears to be a normal weight loss in a patient who is starved for a 24-hour period.

In patients receiving 4 per cent urea added to infusion solutions of 5 per cent

[11] Moore, F. D.: The significance of weight changes after trauma (editorial). Ann. Surg., **141:** 141, 1955.

[12] Paquin, A. J., Jr.: The rate of body weight loss following surgical stress of uniform intensity. Ann. Surg., **141:** 383, 1955.

dextrose in water, there is in general no change in the serum electrolytes as compared to the patients receiving approximately 2000 cc of intravenous fluids in the form of 5 per cent dextrose in water and no urea added. This holds true even with fluid intakes as high as 4000 cc in the 24-hour period immediately following surgery.

We have not found that the administration of urea changes the excretion of sodium, and this is in accordance with what has been observed by other investigators.[13-15] Therefore, sodium chloride is given only in small amounts the day of surgery. The addition of approximately 5 gm. of salt usually will lead to zero sodium balance except in cases where severe sodium retention existed prior to surgery.

It can be concluded that the addition of 4 per cent urea to the standard dextrose in water infusion enables us to administer large fluid volumes without the risk of water intoxication. The increased urinary output thus obtained appears to be a valuable aid in the management of patients following suprapubic prostatectomy.

It may be added that we have recently utilized the principles described in other cases of gross hematuria with equal success.

SUMMARY

Postoperatively, patients can safely be given large amounts of intravenous infusions of 5 per cent dextrose in water without risking any dilution of body fluids provided that a relatively normal kidney function is present and that a solute such as urea is added in a concentration of approximately 4 per cent.

Without the addition of urea, water retention is evident even with moderate fluid loads.

The high urinary output which can be obtained in this fashion has been found most helpful in urological surgery where gross hematuria is encountered.

[13] Mudge, G. H., Foulks, J. and Gilman, A.: Effects of urea diuresis on renal excretion of electrolytes. Am. J. Physiol., **158:** 218, 1949.

[14] Seldin, D. W. and Tarail, R.: Effect of hypertonic solutions on metabolism and excretion of electrolytes. Am. J. Physiol., **156:** 160, 1949.

[15] Miller, H. R. and Feldman, A.: Prolonged use of massive doses of urea in cardiac dropsy. Arch. Int. Med., **49:** 964, 1932.

ACUTE NECROTIZING ANGIITIS OF THE BLADDER: REPORT OF A CASE

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Necrotizing angiitis as a pathological entity has attracted considerable interest in the past two decades. Because sensitization to various drugs, notably the sulfonamides, is an established etiologic factor, one may expect to encounter this disease more commonly in this age of enthusiastic and varied drug administration. The following report concerns a case of necrotizing angiitis in which the predominant clinical manifestations involved the bladder, with symptoms including hematuria and acute abdominal pain. It is probable that the pathological process involved other organs as well as the bladder. Sensitization to the sulfonamide gantrisin is strongly suggested as the causative agent.

CASE REPORT

A 13-year-old boy was admitted to the hospital for emergency treatment on January 23, 1955, because of abdominal pain and frequency of urination with terminal pain followed by gross hematuria.

About 7 or 8 days previously the patient had an illness described as "the flu" with a temperature to 102F and associated with sore throat. He was given one tablet of gantrisin every four hours for five doses. Four days later, the temperature returned to normal, he felt better, and he returned to school. The night before admission to the hospital he noted pain on urination which was most extreme when terminating the act. Urinary frequency became more pronounced and finally gross hematuria was noted on the morning of admission. The patient also had had some abdominal pain with loss of appetite but no nausea or vomiting.

On admission, the patient's temperature was 98.6F, pulse rate 90, blood pressure 120/80 mm. Hg. The boy appeared somewhat pale but not severely ill. The ears, nose, throat, and chest were normal. Abdominal palpation revealed diffuse lower abdominal tenderness, most marked over the right lower quadrant where considerable muscle guard was noted. Definite rebound tenderness was elicited. The penis and testicles were normal. Rectal examination revealed tenderness with suggestive induration high above the prostate, chiefly on the right side.

The urine was grossly bloody. The leukocyte count was 10,450 with 89 per cent neutrophils. The blood urea was 21 mg. per 100 cc.

A plain roentgenogram of the abdomen was negative. The intravenous urogram showed prompt excretion of the contrast medium; the kidney pelves and ureters were outlined satisfactorily and appeared to be normal (fig. 1). There was no demonstrable ureteral obstruction. The bladder shadow, however, showed an unusual deformity involving chiefly the right side and dome of the bladder (fig. 1). In spite of the extensive bladder deformity, there was no ureteral obstruction.

A 16F cystoscope passed easily. The urine was bloody but cleared with one or two washings. Inspection of the bladder revealed an extensive lesion projecting from the right side as a domelike elevation. It had a solid appearance and was dusky red with scattered blackened areas that appeared to be caused by old hemorrhage. The entire surface was irregularly edematous but no areas of ulceration or exudate were seen. In contrast, most of the *left* half of the bladder presented normal-appearing mucosa.

The clinical, roentgen, and cystoscopic findings indicated that the condition was an an acute intraperitoneal inflammatory process (most probably appendicitis) with extension to the bladder. Exploratory laparotomy was advised and performed as an emergency in the late evening on the day of admission.

Operation: A low right paramedian incision was made. Considerable edema of of the abdominal wall was noted. The peritoneal cavity contained a considerable quantity of clear fluid; culture of this fluid later was reported to be sterile. Inspection revealed no evidence of intestinal disease. The appendix was identified and appeared to be normal. Pronounced retroperitoneal edema on the right side had elevated the posterior peritoneum.

Palpation of the bladder intraperitoneally revealed a firm smooth mass involving the right side. The bladder was not fixed. Because the bladder apparently was the site of primary disease, the peritoneum was closed and the incision extended downward suprapubically to expose the bladder. During this procedure

FIG. 1. Intravenous urogram. Note unusual bladder deformity. Upper urinary tract appears to be normal and there is no ureteral obstruction.

extensive perivesical edema was observed chiefly on the right side where it extended laterally for several inches.

When the bladder was opened, a dusky reddish-black, extensive lesion on the right side was exposed. On palpation it was firm and edematous but not hard or nodular. The bladder wall in this area was greatly thickened. Frozen sections of specimens for biopsy taken from several areas were reported to show only inflammatory changes. A generous full-thickness piece of the lesion was removed for permanent section pathologic study following which the bladder was closed around a No. 22 Foley bag, suprapubic drainge catheter. The wound was closed in layers.

Pathological report: The surgical biopsy showed major morphologic changes limited to the interstitial tissues of the bladder and its fatty covering. A marked infiltration of polymorphonuclear leukocytes and extravasated erythrocytes occurred in these areas with some concentration around blood vessels. A profuse involvement of the small arteries and veins, evidenced by a smudging and haziness of their outlines and infiltration by polymorphonuclear leukocytes, was present (fig. 2, *A*). The phosphotungstic acid hematoxylin stain (Mallory) demonstrated large amounts of fibrin within the smudged vessel walls, as evidenced by the intense bluish-purple coloration (fig. 2, *B*). No thrombosis of vessels was noted. The smooth muscle fibers of the bladder were not necrotic, but were focally separated by edema and extravasated red cells. The acute necrotizing process also involved the blood vessels of the fatty envelope of the

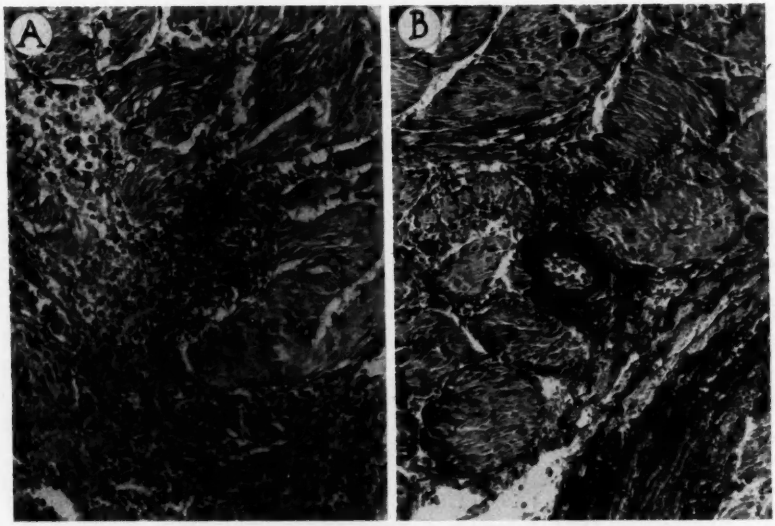

FIG. 2. *A*, section demonstrates three vessels in interstitial tissues of bladder with smudging of walls and perivascular infiltration of polymorphonuclear leukocytes. Interstitial hemorrhage also is present. Hematoxylin-eosin-methylene blue stain; X185. *B*, special stain demonstrating perivascular accumulation of fibrin. Mallory's phosphotungstic acid hematoxylin stain; ×185.

bladder. Pathological diagnosis was acute necrotizing angiitis of a hypersensitivity type.

The convalescence was without serious event. He had a low-grade fever (maximum temperature 101F) which persisted for 14 days. A cystogram made on the twelfth day after operation showed a small bladder but little of the deformity noted on the urogram.

On the seventeenth day following operation a cystoscopic examination showed an essentially normal bladder except for edema surrounding the suprapubic catheter. The suprapubic catheter was removed and the sinus closed by suture. The wound healed promptly and the patient left the hospital three days later.

Past history of this patient, we believe, is of importance as offering a possible explanation for the development of his disease. He has a history of allergy and had received treatment in the Department of Allergy for hay fever, bronchial asthma and allergic rhinitis since the age of 8 years.

In October 1954 he had an illness associated with headache, a mild chill followed by fever (temperature to 101.6F), sore throat and some pain in perineum and penis. The blood count was normal and the urinalysis revealed only an occasional white blood cell. Examination in the Department of Otolaryngology revealed the presence of a purulent maxillary sinusitis and roentgen examination showed cloudiness of the left ethmoid and both frontal sinuses. He was advised to take gantrisin, 2 gm. immediately, to be followed by 0.5 gm. every 6 hours for a week. This medication was taken according to instructions; the patient's condition improved and he returned to school. He apparently remained well until the time of the present hospital admission. It will be recalled that seven or eight days before this hospital admission the patient had been given 5 tablets of gantrisin because of a sore throat. This history immediately suggests the possibility of a hypersensitivity reaction to gantrisin as the explanation for his necrotizing angiitis.

This patient apparently remained well until December 28, 1955, when he was seen again because of diarrhea with three to four watery stools a day and recent bloody stools. There was little if any abdominal pain and no nausea or vomiting. There had been no urinary symptoms and the urine was clear. There was a moderate anemia.

He was admitted to the hospital for gastrointestinal study (E. N. Collins, M.D., Department of Gastroenterology) on January 9, 1956. Urinalysis at that time was entirely negative. Colon x-ray studies revealed findings suggesting chronic ulcerative colitis although proctoscopic examination revealed no local signs of this disease. He was given blood transfusions and placed on appropriate medical management; his condition improved.

A recurrence of the bloody diarrhea necessitated readmission to the hospital on August 16, 1956, for further transfusions and medical management. He continued to have trouble, believed to be due to angiitis (periarteritis nodosa) involving the gastrointestinal tract and probably diffuse disease as well. In November 1956 he was started on ACTH, 10 units twice weekly intramuscularly, and meticorten 2½ mg. daily. In addition to this he was given 500 mg. of chloro-

quine a day and 50 mg. of marsilid every other day. The father reports that the patient occasionally has had mild diarrhea but feels better generally, is gaining weight and has been in school every day. At no time has there been any recurrence of bladder trouble or hematuria.

DISCUSSION

Although necrotizing angiitis has received considerable attention in recent medical literature we have been unable to find another case in which the urinary bladder was the chief organ involved in its clinical manifestations.

Some confusion still exists in the terminology of the angiitides. The term, periarteritis nodosa was introduced in 1866 by Kussmaul and Maier[1] for a degenerative disease of arteries characterized by grossly visible nodes along the arteries at autopsy. Since this time, other vascular lesions of similar type have been described with such terms as rheumatic arteritis, polyvasculitis, temporal arteritis, necrotizing arteriolitis, allergic granulomatous angiitis.

Zeek[2] suggests necrotizing angiitis as the generic term and would classify these cases into the following groups.

1) Periarteritis nodosa—a recurrent or chronic progressive necrotizing inflammatory disease involving chiefly muscular type arteries.

2) Hypersensitivity angiitis—an acute necrotizing inflammation in and around the smallest arteries and veins of the viscera, connective tissue and skin. Larger vessels are involved in advanced cases. Necrotizing glomerulitis is often found and fulminating renal failure may cause death.

3) Rheumatic arteritis—an acute inflammation with minimal fibrinoid necrosis which is always associated with rheumatic fever.

4) Allergic granulomatous angiitis—a chronic disease in which the vascular disease is part of a generalized granulomatous condition. Vascular occlusion may occur in the late stages.

5) Temporal arteritis—a rather rare self-limited disease characterized by granulomatous inflammation and fibrinoid necrosis involving the temporal arteries most frequently.

In 1942 Rich[3] emphasized the role of hypersensitivity in periarteritis nodosa when the disease was observed in patients receiving antiserum for pneumonia. He also noted similar lesions in a patient from the surgical service who had received sulfathiazole intravenously but no serum. Later in the same year he reported periarteritis nodosa in a patient receiving sulfathiazole only.[4] In this case scrotal skin sections five months and one week before sulfonamide therapy

[1] Kussmaul, A. and Maier, R.: Ueber eine bisher nicht beschriebene eighenthümliche Arterienerkrankung (Periarteritis nodosa), die mit Morbus Brightii und rapid fortschreitender allgemeiner Muskellähmung einbergeht. Deutsch. Arch. f. klin. Med., **1:** 484, 1866.

[2] Zeek, P. M.: Medical progress: periarteritis nodosa and other forms of necrotizing angiitis. New Eng. J. Med., **248:** 764, 1953.

[3] Rich, A. R.: Role of hypersensitivity in periarteritis nodosa as indicated by 7 cases developing during serum sickness and sulfonamide therapy. Bull. Johns Hopkins Hosp., **71:** 123, 1942.

[4] Rich, A. R.: Additional evidence of role of hypersensitivity in etiology of periarteritis nodosa; another case associated with sulfonamide reaction. Bull. Johns Hopkins Hosp., **71:** 375, 1942.

was started were normal; whereas nine days after sulfa administration, lesions of periarteritis nodosa were present in the scrotum and widespread throughout the body. It is now generally accepted that this disease, by whatever title, can result from anaphylactic type of hypersensitivity reaction.

Hypersensitivity angiitis in man has been reported from sulfonamides as well as other substances such as dilantin, thiourea, organic arsenicals, Lugol's iodine, the antibiotics, aspirin. Rich[5] describes an anaphylactic type of sensitization due to the production of antibodies which react specifically to a foregin antigen. In this type, the specific antigen causes death of cells as the result of vascular damage which interferes with the nutrition of the cell. The effects are upon the vascular endothelium, causing endothelial necrosis; on smooth muscle, producing spasmodic contraction; and on the collagen fibers which undergo degeneration and fragmentation and altered interfibrillary substance.

It has been shown that sulfonamides can attach to plasma proteins, and the complex so formed can act as an antigen to sensitize the body anaphylactically to the sulfa radical.[6-8] In such cases the administration of sulfa drugs may produce hypersensitivity angiitis and continued administration may produce a fatal reaction. Rich[5] reports that at the Johns Hopkins Hospital there were but six cases of periarteritis nodosa reported in necropsies between the years 1916 and 1935. Sulfonamides were introduced in 1936 and in the years between 1936 and 1946, 38 cases were found. In studies on necrotizing angiitis, Knowles, Zeek, and Blankenhorn[9] found a direct relationship between sulfonamide therapy and hypersensitivity angiitis in seven of 10 cases which came to necropsy. Hematuria had been present in 5 of these 10 cases and was attributed to the renal lesions. No cystoscopic examinations had been performed. Repeated hematuria was also present in five of 13 cases of primary periarteritis nodosa. In one patient, these authors mention that the vascular lesions led to necrosis of the bladder wall and pelvic peritonitis.

In a study of 76 fatal cases following sulfonamide therapy, French[10] reported finding typical lesions "in practically all organs of the body" including the bladder but this organ was not routinely examined.

The sites of predilection of necrotizing angiitis are the kidneys and heart as well as the pulmonary vessels and spleen. It appears to be uncommon in the pancreas and gastrointestinal tract. It is not unexpected that the kidneys would be prominently affected in any acute vascular disease. Thus a necrotizing glomerulitis is a frequent finding in cases terminating fatally.

In the case we have presented, the histologic findings are identical with those

[5] Rich, A. R.: Hypersensitivity in disease. Harvey Lectures, 1946–1947, pp. 106–147.
[6] Schönholzer, G.: Die Bindung von Prontosil an die Bluteiweisskörper. Klin. Wchnschr., **19:** 790, 1940.
[7] Davis, B. D.: Binding of sulfonamides by plasma proteins. Science, **95:** 78, 1942.
[8] Wedum, A. G.: Immunological specificity of sulfonamide azoproteins. J. Infect. Dis., **70:** 173, 1942.
[9] Knowles, H. C., Jr., Zeek, P. M. and Blankenhorn, M. A.: Studies on necrotizing angiitis; periarteritis nodosa and hypersensitivity angiitis. A.M.A. Arch. Int. Med., **92:** 789, 1953.
[10] French, A. J.: Hypersensitivity in the pathogenesis of the histopathologic changes associated with sulfonamide chemotherapy. Am. J. Path., **22:** 679, 1946.

described by others in cases that were caused by angiitis. The history suggests that our patient became sensitized to a sulfonamide compound, gantrisin, in October 1954 and when the drug was again administered in January 1955 a hypersensitivity reaction occurred. It seems unusual that the urinary bladder became the main target organ although the followup history suggests more diffuse organ involvement. The apparently complete recovery of the bladder with simple suprapubic drainage would indicate this to be the preferred treatment.

SUMMARY AND CONCLUSIONS

An unusual and apparently rare disease of the bladder is described and pathologically classified as acute necrotizing angiitis. It is believed to be a hypersensitivity reaction and the evidence strongly suggests reaction to gantrisin.

Complete recovery followed simple suprapubic drainage of the bladder. Cystoscopic examination 17 days after operation showed the bladder had returned to normal. There has been no return of bladder difficulty during a followup of 2 years and 3 months.

The subject of hypersensitivity to sulfonamides is briefly discussed particularly with reference to the production of necrotizing angiitis.

URETERORECTOSTOMY AND PREANAL COLOSTOMY FOR BLADDER EXSTROPHY

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The history of attempts at surgical relief of bladder exstrophy go back more than 100 years to 1851–52 when Mr. Lloyd, a surgeon, and Sir John Simon attempted to divert the urine from the ureters into the rectum by establishing suture fistulas. These attempts were unsuccessful and no further efforts at urinary diversion are reported until the time of Maydl about forty years later (1894). Maydl first dissected out the vesical trigone with the ureteral orifices intact, then, turning the trigone over, he implanted it into the anterior rectal wall. This procedure was successful in Maydl's hands in a number of cases and inspired many variations in technique during the next fifteen years.

Mauclaire, in 1895, performed experiments on animals in which he isolated the rectum, transplanted the ureters into the isolated segment, and made a proximal colostomy. At this time he suggested the possibility of making a perineal colostomy or perineal anus.

Within the next year or two this last suggestion was carried out by Gersuny. The procedure was accomplished in two cases. We have been unable to locate a report by Gersuny himself giving the details of the surgery or the results. The patients apparently lived, for Gersuny's work was reported by a Dr. Foges at a meeting of the Royal and Imperial Society for Physicians in Vienna. This report then appeared in the WIENER KLINISCHE WOCHENSCHRIFT of 1898. The same report was copied in the CENTRALBLATT FÜR CHIRURGIE of 1899. Roughly translated the report is as follows: "The rectum is separated from the sigmoid flexure and in the opening is implanted the freed up ureters together with a portion of the bladder (trigone). The divided sigmoid flexure is then drawn down through an opening in the rectouterine fold in front of the anterior rectal wall and drawn through the anal sphincter and fixed there with sutures, so that the bladder made of the separated rectal portion and the drawn down rectum made from the sigmoid flexure are both under the control of the same sphincter muscle."

A very clear drawing of this procedure appears in Frank Hinman and Henry Weyrauch's very complete review of methods of ureterointestinal implantation which appears in the transactions of this society for the year 1936. Gersuny's name does not appear in the bibliography of this article however, and this made it very difficult to find the source of the report. Bibliographical reference is under the name of Foges and so far as we are able to ascertain, no other report of this work appeared.

This procedure was not further used so far as we know until revived by Drs. Lowsley and Johnson a few years back (1955). About one year ago Johnson reported 17 cases, none of them exstrophy patients. They reported good conti-

nence of the urine in the modified rectal bladder, and also good control as to the bowel content, through the new anal opening. Likewise, Stonington and Eiseman have reported five cases with good results all in adults with bladder tumor. The principle of having the rectal sphincter control both the urinary and fecal outlets was also used in 1912 by Heitz-Boyer and Hovelacque, who brought the proximal bowel segment down behind the rectal bladder. In addition, they tried to bring it immediately under the anal mucosa so as to get the full benefit of the internal portion of the anal sphincter. This procedure never was widely used, so far as we know.

Since its revival, the Gersuny procedure has been used chiefly on older individuals who required cystectomy for carcinoma of the bladder. To use the procedure on the child who has many years of life expectancy requires additional consideration of the long-term possible after-effects of the procedure. This is particularly true in regard to deleterious effects on the kidney function which might appear over many years of time.

Considering the purely mechanical aspects of emptying function, this procedure gives the closest approximation to normal of any of the artificial methods of urinary and fecal disposal. Ideally, it gives complete voluntary sphincter control. It can give an acceptable voiding pattern in that the urine can be held for normal periods of time and stool likewise. It eliminates entirely the need for an appliance. The bowel activity pattern even if not entirely normal, will be a great improvement over any other type of colostomy. The near normal location of the disposal orifices is a great convenience, and a social advantage if not a medical one.

We return then to the possible disadvantages of this procedure. Most important would be any serious damage to the kidneys. Boyce and Vest showed that isolation of the rectal segment from the fecal stream might do away with nearly all the harmful side effects which accompanied ureteral transplantation into the intact bowel. They showed that the urine in such an isolated rectal bladder could be sterilized and maintained in a sterile state and that back pressure effects and electrolyte disturbances need not occur. Others have reported favorable results in the use of the isolated rectum as a urinary reservoir (Kinman and associates; Smith and Hinman; Paull and Hodges).

These results seemed to us to justify trial of this procedure in the child with bladder exstrophy even though there were no known reports of long survival with this procedure. Also, to bolster our determination was the fact that this operation does not bar the use of alternative procedures later on, should the result not be satisfactory.

The patients selected for trial of this procedure were particularly examined for competence of the rectal sphincter. The patients selected also have had essentially unimpaired upper urinary tracts before surgery. The procedure is available for use after attempts at reconstruction of the bladder. One of our cases was in this category, having had many surgical operations for bladder reconstruction, but without success. The age has not been a critical point in selection. One of the cases was under two years of age. We see no reason for not doing this

operation in young children since the aftercare is not a particularly difficult problem.

SURGICAL TECHNIQUE

An attempt was made to reduce the intestinal bacterial flora by administration of antimicrobial agents of the poorly absorbed type. We preferred a four or five day preparation with oral sulfathaladine. Enemas were given preoperatively until the enema return was clear. The patient was placed in the supine position with the thighs abducted. In these young children with bladder exstrophy we found that the perineal portion of the operation could be done without any other special position. In this anomaly the entire perineum is displaced anteriorly and is reached easily. General anesthesia was used in all cases. The duration of the operation was approximately four hours. In the three younger children a lower abdominal transverse incision was made just above the exstrophic bladder but in the adult patient a vertical incision was made in order to avoid an area of skin excoriation.

After entering the abdomen the ureters were identified, isolated and freed from the pelvic brim distally. Each ureter was then divided, the distal end ligated and the proximal end was allowed to drain freely into the peritoneal cavity while the rectal segment was being prepared. The rectosigmoid was divided at or slightly below the level of the promontory of the sacrum between noncrushing (Dennis) intestinal clamps. A small opening was then made in the distal segment and a solution of 1 gm. neomycin in 500 cc of saline was used, to further cleanse this segment. After this we felt no hesitation in removing the previously applied clamp to do the ureterorectal anastomosis through the open bowel lumen. Mucosa-to-mucosa anastomosis was thus done with the ureters pulled through small lateral incisions in the posterior wall of the rectum. The ureters were prepared by cutting the end obliquely and extending the incision for a short way to further enlarge the circumference of the now elliptical ureteral end. Five-0 chromic catgut suture was used to approximate the full thickness of ureteral wall and the rectal mucosa. In general, a single layer anastomosis was used, although on occasion a few supporting sutures were taken between the serosa of the rectosigmoid and the areolar tissue around the ureter. The proximal end of the rectum was closed using two rows of number four-0 chromic catgut suture reinforced with a few silk sutures.

Attention was then directed toward freeing the attachments of the descending colon in order that an adequate length could be brought through to the perineum. The inferior mesenteric artery was isolated a short way from its origin from the aorta and a bulldog clamp was applied here. If the colon did not appear to become ischemic following the application of the bulldog clamp the inferior mesenteric artery was divided and ligated. In none of these cases was there any indication of ischemia after ligation and division of the inferior mesentery artery. In some of the cases the inferior mesenteric vein appeared to limit mobility and it likewise was sectioned after a temporary occlusion with the bulldog clamp.

The lateral attachments of the colon were severed from the left lateral ab-

dominal wall and the mobilization along both the lateral and the mesenteric borders of the descending colon was continued on upward as far as necessary to get adequate length for the colon to be brought out to the perineum. In one of these cases it was necessary to continue this liberation of the descending colon up to and around the splenic flexure. The mesentery was found to be relatively avascular if the dissection was done far enough from the colon itself. Particular attention was given to avoiding trauma to the marginal vessels along the medial aspect of the colon.

After obtaining satisfactory mobilization of the descending colon a transverse perineal incision was made anterior to the anal opening and the external sphincter of the anus was identified and lifted from the internal sphincter and the rectal wall according to the general principles applied in the Belt operation for perineal prostatic exposure. The prerectal space was entered both from above and below and a tunnel was formed anterior to the rectal wall. An intestinal clamp was now passed upward through this tunnel from the perineum and after applying it to the mobilized colon the latter was brought down anterior to the rectum and allowed to open just anterior to the anal opening. The end of the colon was now anchored to the skin of the perineum using interrupted four-0 chromic catgut sutures. The redundant bowel was allowed to protrude and formed a rosette. Although unsightly, these rosettes have caused no discomfort and will be removed at the time of bladder excision.

We did not use drains either from the perineum or from the abdominal wounds, and have not closed the posterior peritoneal incisions either medial to or lateral to the descending colon. The abdominal wall layers were closed and a mushroom catheter was inserted into the rectal "bladder" and left for a period of five days. We did not splint the ureterorectal anastomoses. Penicillin and streptomycin were given parenterally for about six days postoperatively.

CASE REPORTS

Case 1. J. J. was a Negro girl, born July 27, 1953. Preoperative excretory urogram at age two years and nine months showed some dilatation in the lower portions of both ureters. When three years old (July 24, 1956) the operation described above was performed. At operation the ureteral dilation was confirmed, the left side being approximately eight millimeters in diameter. The postoperative course was excellent, and she was discharged in excellent condition after 12 days, passing urine from the isolated rectal segment and stool from the perineal opening of the sigmoid colon. In following this patient, narrowing of the perineal opening of the sigmoid colon was noted and was relieved by finger dilatation.

Six months postoperatively the patient suffered an acute episode of small bowel obstruction and celiotomy was done on February 7, 1957. The obstruction was found to be due to postoperative adhesions, particularly along the mesenteric edge of the mobilized descending colon. She recovered promptly following lysis of these adhesions and her postoperative course has subsequently been good. Her parents state that she has control of both urine and stool and they have found that when she is dressed up in her party dress she remains dry of both

stool and urine for periods up to three hours. Urine culture from the rectal segment on January 11, 1957 disclosed mixed bacterial growth, including E. coli, Proteus, and Streptococcus. Grossly the urine is hazy with mucus shreds; microscopically only a few white blood cells and a few bacteria are seen.

After strenuous crying when seen in the clinic the patient was noted to have no residual urine in the rectal segment. There has been no indication of difficulty in passing the stool. Excretory urogram done two months postoperatively shows a normal upper urinary tract which actually appears improved over the preoperative films. Electrolyte studies done five months postoperatively show sodium 140 meq/L, potassium 4.5 meq/L, chloride 113 meq/L, Co_2 18 meq/L, and nonprotein nitrogen 25 mg/100 ml. Repeat studies done eight months postoperatively revealed chloride 117 and Co_2 19. Her general condition has been excellent. She has had no clinical evidence of pyelonephritis.

Case 2. K. W. was a white male senior in high school whose exstrophy of the urinary bladder had been treated by attempted closure at the age of four years. Numerous unsuccessful attempts were made subsequently to close fistulas. No apparent urinary sphincter activity was observed on preoperative cystourethroscopic examination. This boy was quite uncomfortable due to urinary drainage to the anterior abdominal wall where there was moderate excoriation of the skin. He was attending a special school and wearing diapers. On November 4, 1956, at age of 19 years, the previously described operation was performed. Sulfathaladine and neomycin were used for preoperative bowel preparation. The operative position was that used for synchronous combined abdominoperineal resection of the rectum, and gave very excellent exposure both abdominally and perineally. A vertical left paramedian incision was used in this case to avoid the excoriated area around the fistulas. Surgery was uneventful. The postoperative hospital course was excellent. He was discharged 11 days postoperatively passing urine and stool from the separate openings. He likewise has had mild stricture formation at the perineal sigmoid opening which he has controlled by self dilatation. Urine culture three months postoperatively revealed the presence of Proteus and enterococcus. A "rectometric" study was done postoperatively and disclosed that the maximum pressure within the rectal bladder was 25 mm. of mercury and the capacity was 200 cc. An excretory urogram made two months postoperatively showed dilatation of the lower left ureter but a subsequent urogram, five months postoperatively, showed a normal upper urinary tract. Blood chemistry studies five months postoperatively showed sodium 145, potassium 5.1, chloride 111, Co_2 24, nonprotein nitrogen 27. This patient's general health prior to the operation performed here was fairly good, although he is very thin for his body build. Recently he has gained a few pounds in weight and his general health has been good with no clinical evidence of pyelonephritis. His urine control has been excellent for which he is very grateful. Residual urine was 5 cc. The control of stool was not good for several months as he lost both formed and liquid stool without warning in spite of the fact that digital examination of the sigmoid opening indicated a fairly vigorous voluntary sphincter muscle action upon this segment. His control of the stool has improved a great

deal in recent months and, although still not perfect, he is working every day with a minimum of difficulty in stool control. He now reports that within recent weeks he has been able to discriminate between stool and gas in the sigmoid and he claims considerable skill in control of the latter.

Case 3. R. G. was a white girl born on May 10, 1955. When first seen, the advisability of diversion procedures to the colon was questioned because it seemed that this child had subnormal anal sphincter activity. On following this patient over several months it seemed that the anal sphincter activity improved somewhat and she was finally considered for the above procedure. Excretory urogram done preoperatively, at age four months, showed a normal upper urinary tract. On September 18, 1956, at 16 months of age, she was operated upon according to the technique described. The postoperative recovery was excellent and she was discharged 10 days following operation. Postoperatively her general condition has been excellent, with no clinical evidence of pyelonephritis. Because of her age (still less than two years) it is difficult to determine if there is adequate control over the urine and stool; however, the mother feels that there has been some progress in recent attempts at toilet training. Urinalysis done five months postoperatively discloses 0–1 white cell per high power field and the urine is grossly clear except for mucus. There is no residual urine in the rectal bladder. The stool has been formed or soft and again control is difficult to determine. An excretory urogram made two months postoperatively showed a normal upper urinary tract. Blood chemistry studies five months postoperatively showed sodium 145, potassium 5.2, chloride 110, Co_2 23, and nonprotein nitrogen 23. Seven months postoperatively the blood chemistries were again normal with sodium 144, potassium 4.4, chloride 109, Co_2 23, nonprotein nitrogen 18.

Case 4. S. E., a white boy born on October 20, 1954, was noted by his parents to have unexplained fevers which perhaps were related to ascending urinary tract infection. Excretory urogram at age of two years showed mild dilatation of the right ureter. The parents noted constipation in the patient and a barium enema was stated to show a redundant colon. He entered the hospital in June 1955, at age of eight months because of the development of an incarcerated inguinal hernia. Abdominal exploration at this time disclosed a gangrenous small intestine which was resected. A few weeks following this procedure both left and right inguinal hernias were repaired through inguinal incisions. The operation for urinary diversion described above was performed November 27, 1956, at the age of 25 months. The postoperative course was excellent, the patient being discharged fifteen days postoperatively passing urine and stool from the separate openings. Two weeks postoperatively the chemistry values were sodium 137, potassium 4.7, chloride 109, Co_2 25, nonprotein nitrogen 25. Two and one-half months postoperatively the chemistry levels were sodium 142, potassium 4.9, chloride 117, Co_2 19, nonprotein nitrogen 25. When repeated again four and one-half months after operation, values were obtained of sodium 144, potassium 5.0, chloride 112, Co_2 23, nonprotein nitrogen 22. The extent of control over urine and stool is difficult to assess in this young patient, now two and one-half years old, but the mother feels that both urine and stool control are probably present. The residual urine is less than 20 cc and the urine is grossly clear with

only an occasional white blood cell seen microscopically. The general condition of this patient has been most excellent. The mother states that he has been considerably improved compared to his preoperative status. He has had no further unexplained elevation of temperature.

DISCUSSION

In all of the cases this operation has resulted in a satisfactory urinary reservoir under sphincter control. This has been accomplished without serious deleterious effects on the upper urinary tract in any case. These findings are in accord with those of practically all authors who have previously reported the use of the isolated rectum as a urinary reservoir, when the procedure has been done as a primary procedure with a previously normal upper urinary tract. High pressures do not develop in the isolated rectal bladder as they do in the normal rectum as a result of peristaltic waves or of defecation efforts. Pressure studies of such rectal bladders done by Smith and Hinman and Paull and Hodges have brought out this point of relatively low pressure in the rectum when used as a urinary reservoir. This helps explain why no kidney damage is reported by the authors using this procedure. There has been no instance of pyelonephritis in any of our cases, and this too is in accord with the experience of others. The urine in our cases has not been sterile but the cell counts are low and any infection present has not seemed to involve the kidneys but rather to remain localized in the lower tract.

None of our patients has had symptoms of electrolyte imbalance. There has been no anorexia or any other premonitory symptom of acidosis. However, in two cases, electrolyte determinations have shown moderate variation from normal on one or more determinations following surgery. In these patients, there have been found chloride levels of 117 meq/L with CO_2 levels of 19 meq/L. At the time of these findings, the patients were in apparent perfect health and were feeling well. In one case, these values, two months later, were chloride, 112 mEq. and CO_2 23 mEq.; but in the second case, they have not returned entirely to normal. We will continue to watch the electrolyte levels in these patients. We do not anticipate serious clinical effects since the area of bowel mucosa exposed to the urine is so much smaller than that in conventional ureterosigmoidostomy into the intact bowel. It has been definitely shown that some electrolyte reabsorption does occur from the isolated rectal bladder (Boyce 1951, Parsons and associates 1952). The good kidney function which this procedure permits will help offset the reabsorption that occurs and we hope that it will prevent any serious consequences. Dr. Creevy's experience with isolation of the rectum some time after ureterosigmoidostomy is not a directly comparable situation, but it, too, affirms the fact that there is significant reabsorption from the distal colon and rectum. Although the rectum may reabsorb less actively than the higher portions of the bowel, such as the ileum, still the urine is held in contact with the rectal wall for a matter of hours as compared to uretero-ileostomy in which emptying is usually quite rapid.

The control of the stool has been difficult to determine in the three younger patients of our group. The bowel movements are periodic in the children at in-

tervals of one to several times a day. However, because of the age of the children, it cannot be said at this time that these are entirely voluntary. The one older patient of this group has had a delay of several months in securing satisfactory control of stool and gas. His early difficulty seemed to be due more to incomplete sensation of stool or gas being present in the terminal sigmoid rather than due to a defect of voluntary muscle strength. Perhaps a new system of co-ordination must be set up to insure adequate sustained external sphincter tone after this operation.

Difficulties with stool control have not been mentioned in the reports of others using this procedure. The fact is that only the external sphincter is working on the bowel segment containing stool. The internal rectal sphincter is an intrinsic part of the rectal wall and does not act on the sigmoid colostomy after the procedure described here. The operation described by Heitz-Boyer and Hovelacque was designed to make use of the internal as well as the external sphincter but its use has not been reported recently.

SUMMARY

Four patients with exstrophy of the bladder have been operated upon by a method originally used by Gersuny in 1895. The early (nine to six months) functional results have been quite encouraging. Harmful effects on the upper urinary tract have not been noted. Mild subclinical acidosis has been found by blood chemistry studies in two cases. This effect will be followed closely for proper evaluation of the use of this procedure in young children.

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A METHOD OF LENGTHENING AND REPAIRING THE PENIS IN EXSTROPHY OF THE BLADDER

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Four important factors in the correction of the external defects in exstrophy of the bladder in the male are: 1) closure of the lower abdominal hernia, 2) removal of the mucous membrane of the bladder, 3) release of the dorsal angulation of the penis, and 4) formation of an adequate urethra with preservation of the prostatic ducts.

The technique described here achieves a lengthened penis and an adequate urethra by applying the well-established principles used in the first-stage repair of hypospadias. The necessary additional covering for the longer penis is obtained from a scrotal skin tube, thus adapting the principle of Wehrbein,[1] who used a similar type of tube in his two-stage method of repair of hypospadias.

That a channel must be provided for the outflow of prostatic fluid was well-illustrated by the case of one patient surgically treated by an earlier method, and for whom ejaculation was always painful. A perineal diverticulum finally developed, which was fixed open by suturing its edges to the perineal skin (fig. 1). Subsequent ejaculation was painless.

Previous methods have been successful in forming a urethra and closing the abdominal defect, but have not effected release of the dorsal penile fascia and so have not provided for lengthening of the penis. H. H. Young[2] was able to place the urethra in an almost normal position by freeing the margins of the urethral mucosa and separating the corpora cavernosa. In this technique, the abdominal closure was strengthened by flaps from the anterior rectus sheath. This was not necessary, however, in the cases in the present series. A further refinement was used by Mitchell and Hardin,[3] who mobilized a pedicled skin graft to close the abdominal skin defect. This thick skin was not entirely suitable, however, for covering the proximal portion of the dorsum of the penis. In none of the recorded techniques was release of the angulated penis achieved.

TECHNIQUE

Urinary diversion has been accomplished by ureterosigmoidostomy, usually without proximal colostomy. Perhaps this is not the best way, but it has been satisfactory in general. An ileal conduit, or, better, a rectal bladder, especially with the distal end of the sigmoid brought through the rectal sphincter, as done in our latest case, is now preferable. The type of diversion used does not alter the technique of subsequent plastic repair.

Drs. Harry M. Blackfield and Gerald M. Miller were active in the initial stages of development of the technique.

[1] Wehrbein, H. L.: Hypospadias. J. Urol., **50:** 335, 1943.

[2] Young, H. H.: Exstrophy of the bladder; first case in which normal bladder and urinary control have been obtained by plastic operations. Surg., Gynec. & Obst., **74:** 729–737, 1942.

[3] Mitchell, A. D. and Hardin, C. A.: Methods of repairing exstrophy of bladder. Amer. Surgeon, **18:** 156–159, 1952.

FIG. 1. Result of obstruction to prostatic secretions with exstrophy of bladder. Perineal fistula was required to drain prostatic fluid.

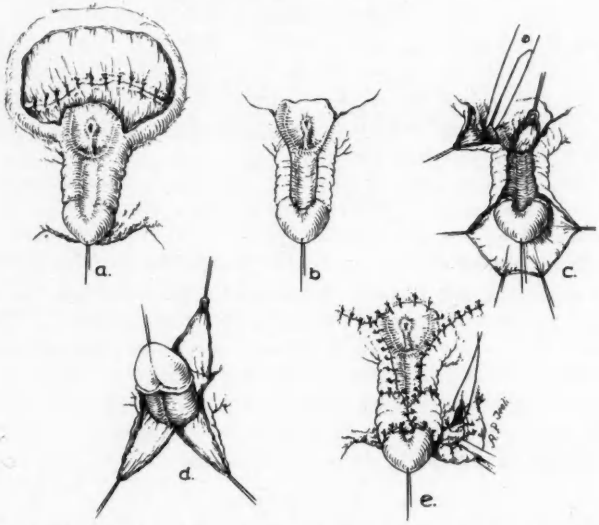

FIG. 2. First-stage repair. *a*, Mucosa and submucosa have been removed from detrusor, which is inverted and closed by bringing abdominal fascial layers down to interpubic fascia. *b*, Incisions are made on dorsum and about glans. *c*, Penis is lengthened by removal of fibrous tissue at Buck's fascia and division of two portions of suspensory ligament of the penis. *d*, Ventral prepuce is split. *e*, Prepuce is swung around to cover distal portion of penis, while urethral mucosa proper covers proximal end. Skin tube is raised from scrotum.

Cystectomy has been done by excising the mucosa and submucosa from the entire detrusor, leaving a ring of mucosa around the ejaculatory ducts (fig. 2, *a*). The detrusor is merely pushed down into the abdominal cavity, and the thickened, fused, fascial layers are brought down to the interpubic fascia with heavy, chromic catgut sutures. The abdominal skin can usually be undermined and either moved down to join the mucous membrane of the prostatic urethra (fig. 2, *e*), or closed in a Z-fashion from side to side.

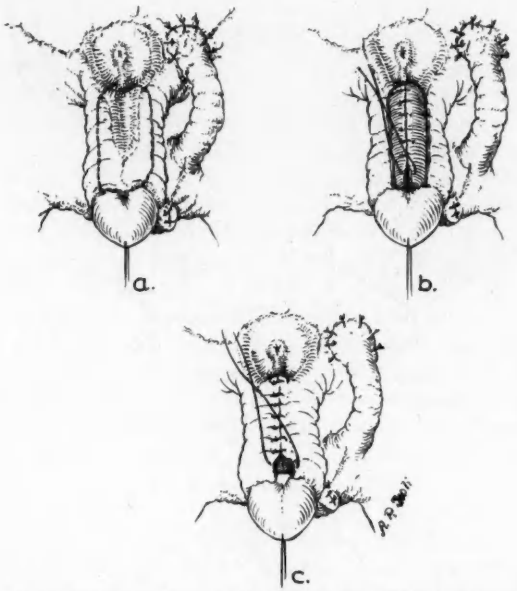

FIG. 3. Second-stage repair. *a*, Lower end of skin tube is moved up to margin of prostatic urethra. *b*, Urethral tube is made by rolling dorsal skin inward. *c*, Defect is covered by redundant dorsal skin.

First-stage repair of epispadias is best done at the same time as the cystectomy. An incision is made along the margins of the dorsal urethral mucosa; it is then carried as a circumcision around the glans (fig. 2, *b*). This allows removal of the fibrous tissue at Buck's fascia (fig. 2, *c*). At the same time, the dense fibrous bands (? divided suspensory ligament of the penis) holding the corpora cavernosa at the crura are cut with scissors (fig. 2, *c*) to release the base of the penis. These two steps lengthen the penis considerably.

The ventral prepuce is split (fig. 2, *d*) and moved dorsally to cover the distal portion of the penis, since the urethral mucosa proper now only reaches to just beyond the midpoint (fig. 2, *e*).

A "Wehrbein" skin tube is raised from the left half of the scrotum and will be used to cover the defect produced in the third stage.

Second-stage repair of the epispadias follows the first in 3 to 4 months. The lower end of the skin tube is severed and attached to the margin of the suprapubic skin near the prostatic urethra (fig. 3, *a*). Incisions are made along the dorsum, which allow a urethral tube to be formed (fig. 3, *b*). This in turn is covered by the redundant dorsal skin originally supplied by the prepuce (fig. 3, *c*).

Third-stage repair of the epispadias is begun by freeing the margins of the mucous membrane of the prostatic urethra (fig. 4, *a*). Division of the distal end of the skin tube allows it to be swung up and opened (fig. 4, *b*). The urethral mucosa is closed by inversion with 4-0 chromic catgut sutures (fig. 4, *b*) and the resulting raw surface is covered with the opened-out skin tube (fig. 4, *c*).

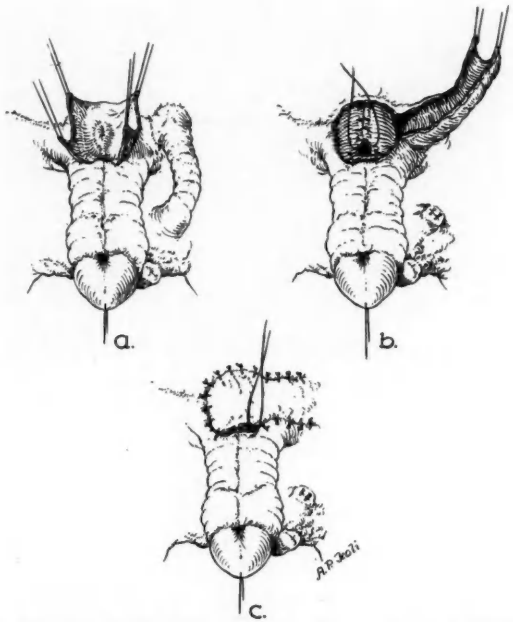

FIG. 4. Third-stage repair. *a*, Margins of mucous membrane of prostatic urethra are incised, and *b*, closed by inversion. Skin tube is freed at distal end and opened, to cover, *c*, remaining raw surface.

FIG. 5. Typical cosmetic result. Note horizontal penis, dorsal urethra and filled in pubic defect. (Case D. C.)

RESULTS

Ten boys have been operated upon by the described technique. Three separate stages of repair were used in the eight completed cases. In the two most recent, and so incompleted, cases, the cystectomy was combined with the first-stage repair.

The increased length of the penis, which has been accomplished by dissection of the mucous membrane and its underlying fascia from the dorsum and severing the heavy, fibrous bands which attach the penis to the pubes, has been quite impressive (fig. 5). It is comparable to the release of the penis obtained in the first stage of repair of hypospadias.

A slight separation of the opened skin tube occurred at the base of the penis in seven cases after the third stage. Two explanations have been suggested: One is that the pressure dressing caused maceration and movement; the second is that the skin tube was not of sufficient length or diameter, so that tension caused the edges to heal poorly. The latter is especially harmful in a field notoriously difficult to sterilize. Making a wider, thicker tube, and keeping the occlusive dressings in place only six or eight hours, appear to have obviated these difficulties, especially if Aeroplast spray is used as the primary dressing.

A second hazard, occurring in two cases at the second stage, was the separation of the end of the skin tube after it had been sutured next to the base of the bladder. The causes here are the same as those producing skin separation at the final stage. Since using a wide flap of skin for the tube, we have not observed this complication.

SUMMARY AND CONCLUSIONS

A three-stage technique is described for lengthening the penis and correcting its dorsal angulation, and for constructing a prostatic and pendulous urethra in the male child with exstrophy of the bladder.

At the first stage, the penis is released by raising the distal urethral mucosa and by releasing the suspensory ligaments of the penis. The mobilized prepuce covers the resulting distal defect. A skin tube is then raised from the scrotum.

At the second operation, the distal urethra is formed by infolding the dorsal skin. The skin tube is moved adjacent to the base of the penis.

At the final stage, the prostatic urethra is closed and covered with the opened-out skin tube.

Ten cases are reported which have been operated upon by this technique. In all of them the penis has been effectively lengthened.

CONGENITAL DEFICIENCY OF THE ABDOMINAL MUSCULATURE AND ASSOCIATED GENITOURINARY ANOMALIES: A REPORT OF 22 CASES

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On the pediatric urological service of the Squier Clinic, 22 children have been seen who had congenital deficiency of the abdominal musculature, with or without associated genitourinary anomalies, since 1940. Before 1947 we had recognized only one patient with this syndrome, but since our interest and that of our colleagues on the pediatric service was heightened by the reporting of nine of our cases by Drs. Eagle and Barrett in 1950, we have seen from one to three new cases each year since that time. Twenty of the 22 children were males, and four of the 22 were Negroes. These children were usually brought in during the first few days of life because of a large, flaccid abdomen through which the viscera could be palpated easily and through which the peristaltic movements of the intestines were clearly visible. The seriousness of the large size of the abdomen was suggested by the fact that two of the children had sustained brain or spinal cord injuries during efforts to extract them at the time of delivery.

Because of the lack of musculature in the abdominal wall the rib cages of these children did not retain the usual cylindrical shape and the costal margins usually flared out widely over the large abdomen. The diaphragm was usually flattened out as a result. This embarrassed respiratory function sufficiently that the children were very vulnerable to pneumonia. Eighty five per cent showed some evidence of obstruction to the bladder outlet, with severe dilatation of the bladder, ureters and kidneys. The testes had failed to descend in 18 (90 per cent) of the 20 male patients. The testes were commonly found attached to the mid-ureter, where a midline incision was required to reach them whenever orchiopexy was undertaken. Anomalies of the lower extremity were present in nine (41 per cent), of whom six had bilateral clubfoot, one had unilateral clubfoot, one had a severely shriveled leg and the other had an absence of the lower leg on one side. Eleven (50 per cent) of the patients had died before the age of 19 months and seven of these 11 had died within 12 days of birth because of severe kidney deficiencies or the replacement of the kidneys by a few cysts, with hypoplasia of the kidneys. The others died of pneumonia or kidney abcesses.

Other associated anomalies were frequent. For instance, 28 per cent had anomalies of the intestines, ranging from two cases of abnormally loose mesentery of the cecum, to one megacolon, one imperforate anus, one anus emptying into the bladder, one atresia of the duodenum and one cystic fibrosis of the pancreas. Other gastrointestinal anomalies may have been present but were not detected because the patients did well or because no autopsy was obtained (one case). Cardiac anomalies were detected in five who came to autopsy and there were marked heart murmurs in two others, as well as electrocardiographic

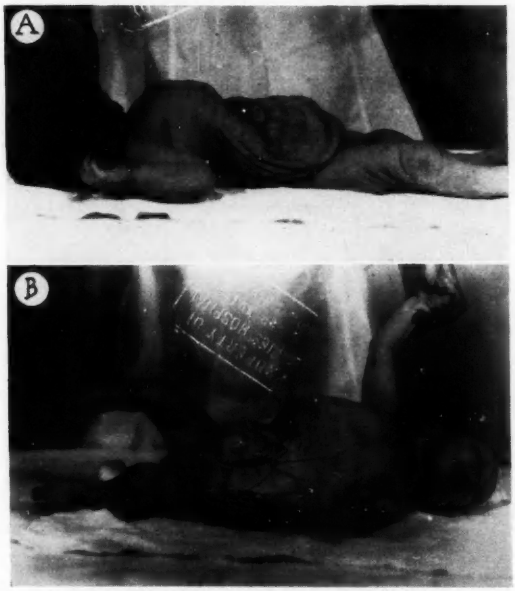

FIG. 1. New-born child, with complete absence of abdominal musculature both above and below umbilicus, who died at eight days after birth from uremia due to destruction of genitourinary tract. Testes were not descended and costal margins flared out markedly. Urachus was patent and drained urine soon after umbilical cord was cut.

changes in a third, for a total of eight of the 22 patients. Extra fingers or web toes were noted in two other patients. Some of the findings in these 22 cases are tabulated in table 1.

PATENT URACHUS

The urachus was patent and draining urine onto the abdominal wall in exactly 50 per cent (11) of our patients. In most of these it appeared to represent the fact that the obstruction of the urinary tract was so severe that the allantoic remnant failed to close off, and extended up into the umbilical cord. When the cord was cut at birth, this tract then became open to the outside and began to leak urine. Of the 11 patients with a draining urachus, nine were dead within the first nine months of life and seven of the nine had died within the first 12 days after birth. They did not necessarily die because of the open urachus, but because of severe kidney damage, probably associated with the fact that the pressure in the urinary tract had been sufficiently severe to cause the urachus to stay open. Of the two who had an open urachus and survived, one healed spontaneously and the other was closed surgically when the patient was two years old. It appeared that the urachus might represent a safety valve for the obstructed bladder if the kidney damage was not so severe as to fail to support life. It is noteworthy that the incidences of these associated phenomena are

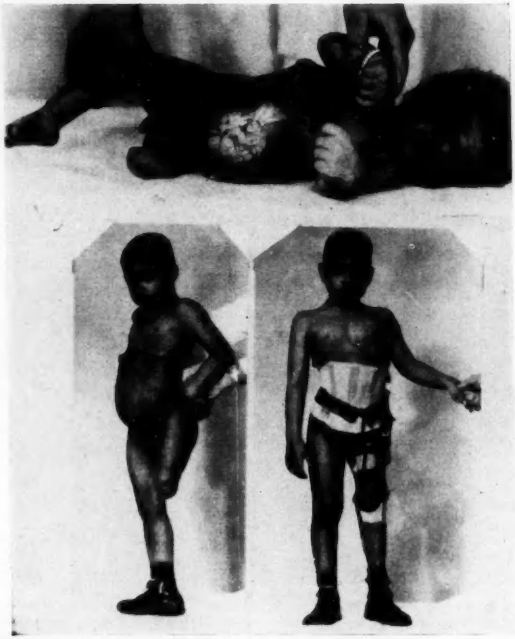

FIG. 2. Photographs of same child at birth (above) and at age four years (below) showing that in spite of complete lack of abdominal musculature, patent urachus, missing leg and undescended testes, growth and development have been satisfactory when urinary drainage was corrected and corset and other proper supports supplied.

similar to those reported in the literature for this syndrome. The first nine patients in table 1 are those previously reported in 1950 by Eagle and Barrett, from this hospital. The remaining cases have been discovered since that time. One of the original nine cases was a boy (C.E.) of Dr. Victor Marshall's from the New York Hospital, whose followup information he has graciously provided for us. This child is doing well following bilateral operations to shorten and reimplant the ureters.

PROGNOSIS

Both in this series and in the accumulated literature, approximately half the patients died within the first two years of life, usually because of severe damage to the kidneys from the urinary obstruction or, less often, from other causes such as cardiac anomalies or pneumonia due to the embarrassed respiratory apparatus. Scattered cases in the literature have been reported as living to age 50 or 70 but no information was available as to whether or not genitourinary anomalies were present in these patients. Of our own series, the two oldest children are now 13 years old and doing well. If the urinary tract can be provided with free drainage, if the kidney damage is not too extensive and if support can be provided for the flaccid abdomen there is no reason why these

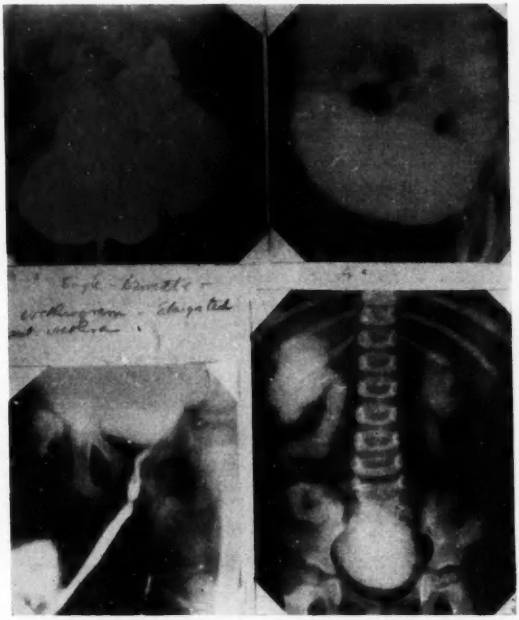

FIG. 3. Shows dilated urinary tract at birth (upper left) and at age four years (lower right). Dilated urinary bladder is seen lying against inner surface of lower abdominal wall in photograph in upper right corner. Elongated, narrowed urethra can be seen in urethrogram in photograph at lower left. This patient had patent urachus closed, bladder neck obstruction resected and dilated and is now voiding normally and walking well with corset and artificial leg.

patients might not have a life expectancy in proportion to the amount of functioning kidney tissue still present when the condition is discovered. Transurethral or open resection of the bladder outlet usually sufficed, but permanent diversion of the urine was necessary in a few cases. Most of these children are still young and their final urinary status is not yet settled.

PATHOGENESIS

Several intriguing theories have been advanced as to the relationship of the dilated urinary tract and the deficiency of the abdominal musculature. The frequency of the association of the two conditions is so great as to suggest a cause and effect relationship. However, our observations on this group of patients have led us to believe that there is no direct cause and effect relationship between the dilated urinary tract and the deficiency of the abdominal muscles. We realize that the two conditions do usually occur simultaneously but feel that they are not necessarily dependent on each other for their causation.

The most popular thesis which has been advanced suggests that the bladder dilates due to obstruction at the bladder neck and that the distended bladder causes pressure against the muscles of the abdominal wall, interfering with their

TABLE 1. *Children with deficient abdominal musculature*

No.	History No.	Sex	Race	Age Diag.	Bladder Outlet Obstruction	Dilated Urinary Tract	Testes Down	Urachus Patent	Deformity of Feet	G. I. Abnormality	Cardiac Pathology	Age Died	P.M. Done	Cause of Death	Siblings with Anomalies
1	909233 T. P.	M	C	Birth	Bar at bladder neck	Yes	No	No	Hypoplastic rt. foot	None	None	Alive			No sibs
2	902262 J. M.	M	C	Birth	Bar	Yes	No	No	None	None	Mild murmur	Alive			1 br; OK
3	N. Y. Hosp CE	M	W	Birth	None noted	Yes	No	No	Clubfoot bilaterally	None	None	Alive			Unknown
4	916736 R. V.	M	W	Birth	Bar	Yes	No	No	None	None	None	Alive			Unknown
5	816088 M. L.	M	W	5 yrs.	Bar	Yes	No	No	None	None	Mild murmur	Alive			No sibs
6	677886 C. C.	M	W	Birth	Diverticulum compressed urethra	Yes	No	Yes	Clubfoot bilaterally	Loose cecal mesentery	None	12 days	Yes	Abscesses of kidneys	Unknown
7	592767 K. F.	M	W	Birth	Bar	Yes	No	Yes	None	None	None	6 mos.	Yes	Ruptured bladder by dilator	No sibs
8	937242 B. C.	M	W	Birth	Bladder not connected with urethra	Yes	No	Yes	None	Loose cecal mesentery	Anomalies of pulmonary arteries	5 hrs.	Yes	Cerebral hemorrhage and uremia	No sibs
9	934363 Bain	M	C	Birth	True "valves" at veru	Yes	Yes	Yes	None	None	Open foramen ovale	0 days	Yes	Stillborn, neck broken in extraction	1 br; OK
10	999832 M. D.	F	W	Birth	None	No	Female	No	None	Cystic fibrosis of pancreas	None	19 mos.	Yes	Pneumonia, cystic fibrosis of pancreas	No
11	080336 H. W.	M	C	Birth	Stricture of bladder neck	Yes	No	Yes, closed by surgery	Left leg absent	None	None	Alive			No sibs
12	077863 J. P.	M	W	Birth	Unknown	Yes	No	Yes	None	None	None	8 days	No	Uremia	No
13	064196 A. C.	M	W	Birth	True "valves" at veru	Yes	No	No	Clubfoot bilaterally	None	None	24 days	Yes	Hypoplastic kidneys, bladder neck obstructed	No
14	066366 S. E.	M	W	Birth	Unknown	Yes	No	Yes, but healed later	Clubfoot bilaterally	None	Severe heart murmur	Alive			No

15	103860 N. M.	M	W	9 yrs.	Stricture of bladder neck	Yes	No	No	None	Megacolon	None	Alive			1 br. has unilat. hydronephrosis
16	153460 L. S.	M	W	Birth	Stricture at verumontanum	Yes	No	Yes	None	None	None	62 days	Yes	Suppurative pericarditis	1 br. has clubfoot
17	058216 E. R.	M	W	Birth	Stricture of bladder neck	Yes	No	No	Clubfoot bilaterally	Imperforate anus, malrotated midgut	None	Alive			1 sister; OK
18	254393 S. W.	M	W	Birth	Stricture of bladder neck	Yes	Yes	No	None	None	None	Alive			No sibs
19	266739 L. B.	M	W	Birth	None	No	No	No	None	None	None	Alive			Twin br. stillborn: hydramnios 3 sibs OK
20	291797 B. L.	M	W	Birth	True "valves" at veru	Yes	No	Yes	Clubfoot, rt.	None	Anomalies of pulmonary vessels, open foramen ovale	6 days	Yes	Pneumonia	2 sibs OK
21	209715 R.	F	W	Birth	Pinhole urethra in clitoris	Yes	Female	Yes	Clubfoot bilaterally	Atresia duodenum, rectum in bladder	Two chambered heart anomaly, pulmonary vessels	2 hrs.	Yes	Cardiac anomalies	No sibs
22	100656 T. B.	M	W	Birth	Bar	Yes	No	Yes	None	None	EKG "abnormal"	11 mos.	No	Pyelonephritis (at home)	1 sister L & W

development and resulting in atrophy or hypoplasia of the musculature in this area. This possibility is supported by the fact that the most frequent muscle deficiency has been reported to exist in the region of the lower rectus muscles, where pressure from a distended bladder would come to bear. Furthermore, it has also been observed that the next most common areas of abdominal muscular deficiency are those adjacent to the bladder area, whereas the musculature of the abdominal wall at the points most distant from the bladder, namely, in the flanks and the subcostal areas, shows no deficiency of abdominal musculature. It has been suggested that the dilated ureters and bladder block the testes from descending. Nevertheless, it appears to us that the following arguments represent a strong case against the theory that the pressure of the distended bladder *causes* faulty development of the abdominal musculature.

Argument No. 1. Two of our patients, Nos. 10 and 19 on table 1, had normal urinary tracts with no distention of the bladder, yet had marked deficiencies of the abdominal musculature. One was a male and one was a female. Neither patient had obstruction of the bladder neck and the male did not have undescended testes; both testes were in the scrotum. The muscular deficiency in these two patients certainly did not result from the pressure of a dilated bladder.

Argument No. 2. Many other patients exist who have very large urinary bladders as a result of obstruction, yet there is no deficiency of the abdominal musculature. If the pressure of a distended bladder is likely to cause a failure of development of the abdominal musculature, the muscular deficiency should be a very common finding, rather than a very rare finding. It has been suggested that perhaps some cases of obstruction occur at a later date or at a later stage of development in the embryo, after the abdominal muscles have formed, so that these patients show no muscle defects. This appears to us to be unlikely.

Argument No. 3. Deficiency of abdominal musculature has often been observed in areas of the abdominal wall which could not possibly be pressed upon

FIG. 4. Muscular defect was primarily on right side. Patient had bladder neck obstruction, dilated urinary tract, undescended testes and withered right foot.

FIG. 5

FIG. 2

FIG. 5. Another child where deficiency of abdominal musculature was primarily unilateral, on right side. This child also had a dilated urinary tract, undescended testes and a heart murmur. His growth and development have been good, after therapy.

FIG. 6. Child had no urinary symptoms noted until age of nine when he was found to have greatly dilated urinary tract due to fact that urine was mildly infected. Child has refused operation but has tolerated inlying urethral catheter well and has shown some recovery of kidney architecture after prolonged catheter drainage.

by a dilated urinary bladder; for instance, in areas above the umbilicus and in the flanks, where the bladder does not extend at any time, even when distended.

Argument No. 4. Unilateral distribution of areas of deficiency of the abdominal musculature is sometimes observed, as in cases 1 and 2 (figs. 4 and 5). Here the deficiency was most marked in the upper right quadrants of the abdomen, far removed from any possible pressure by a dilated urinary bladder. Another one of our cases showed a marked muscular deficiency in the left upper quadrant.

Argument No. 5. Histological studies of the abdominal musculature remnants which have been found in the abdominal walls of these children are reported to be much more suggestive of hypoplasia than of atrophy of differentiated muscle.

There also appear to us to be arguments against the other main theory, namely, that the muscle deficiency in the abdominal wall is the primary lesion, and that the dilated urinary tract results because the abdominal muscles are necessary as accessory muscles of micturition, that the urinary tract empties poorly and therefore dilates when the muscles are deficient. The arguments against this theory are as follows:

Argument No. 1. Two of our patients, Nos. 10 and 19, had flaccid abdominal walls yet their urinary tracts did not dilate as a result. This particular argument is weakened somewhat by the fact that both of these patients had some trace of rectus muscle or of rectus fascia over the bladder area even though there was obvious severe deficiency of the other muscles of the abdomen and a partial deficiency of the recti.

Argument No. 2. A bladder outlet obstruction was demonstrated in 85 per cent of these patients. This is a strong argument that the urinary tract dilatation is due to obstruction of the bladder outlet rather than to the lack of abdominal musculature. Moreover, the walls of the bladder were usually thickened and trabeculated.

Argument No. 3. Patients with omphaloceles have no anterior abdominal musculature, yet do not commonly have dilatation of the urinary tract.

In spite of these strong arguments we feel that this theory bears more investigation. A suggestion that this condition is due to intrauterine poliomyelitis was refuted by the finding of a normal spinal cord in several of our patients, and in some cases in the literature that came to autopsy.

SUMMARY

When a deficiency of the abdominal musculature is found, dilatation of the urinary tract will usually be found. However, we believe that the defect of abdominal musculature and the dilated urinary tract are not cause and effect but instead are associated anomalies. The dilated urinary tract appears to us to be usually due to bladder outlet obstruction, frequently in the form of a membrane across the urethra at the level of the verumontanum of the type called "true valves of the urethra." The close association of these two anomalies may be due to a fault in the same organizer of the embryo, at some early stage, or to an insult occurring partway in the development of the embryo. It can not be argued that these two anomalies occur in otherwise normal children, as witness the fact that 40 per cent had anomalies of the legs, 28 per cent had anomalies of the gut and several had anomalies of the heart, pulmonary blood vessels and fingers. It is not even possible to say that these anomalies are limited to the lower half of the body.

Therapy must be directed to the relief of any bladder outlet obstruction and to the relief of other points of obstruction which may have developed due to the fact that the ureters have become tortuous and that the convolutions have become bound together by adhesions, causing kinks and additional points of obstruction. These may require nephrostomy first and straightening of the ureters later. Corsets or other therapeutic measures must be used to support the abdomen. In this way intestinal function will be improved, posture will be improved, and respiratory function will be improved when the dome of the diaphragm can be restored by maintaining intra-abdominal pressure.

From the clinician's standpoint it is essential that it be recognized that when a child has a flaccid abdomen, he is likely to have severe dilatation of the urinary tract. Among our patients, it appeared that if the condition was not recognized and treated, the chances were ten to one that the child would die an early death from uremia.

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DISCUSSION

Dr. Frank Hinman, Jr. (San Francisco, Calif): I would like to discuss Dr. Kiefer's paper. We had a similar problem, and were about to embark on Dr. Tracy Powell's concept, that of making a conduit from the bladder through the anal sphincter. When you think about it, it has certain disadvantages. It requires taking a segment from the colon, with a separate anastomosis to the bladder, and requires that the new anus carry urine. With the Gersuny operation, however, you can use the old anus for urine, and the colostomy through the sphincter to carry the feces. I don't want to steal any of Dr. Kiefer's thunder, but we are quite enthusiastic about this procedure, and I just happened to have a series of color slides which I think show very nicely how technically successful this operation is.

In exstrophy at least—we have not done it in the adult—the Gersuny operation is an extremely simple procedure because everything is laid out in front of you. We use a transverse incision.

[Slide] The sigmoid is freed up, and a bulldog clamp placed on the inferior mesenteric vessel to check viability. We do the anastomoses as Dr. Willard E. Goodwin has described—bringing them through the bowel behind, through little transverse incisions.

[Slide] This demonstrates very nicely how straight these ureters are after anastomosis.

[Slide] We planned and made a longer rectal pouch. From our experience with rectal bladders, we know we need to have 200 to 300 cc capacity. You can see that there is a nice redundant loop of rectum sigmoid.

The anal incision is made just like the Belt prostatic incision.

You can see there is sigmoid to spare. We did a direct anastomosis, which seemed better than leaving redundant sigmoid protruding.

[Slide] Here is the new anus from the sigmoid, and here is the old anus underneath, which will carry the urine.

[Slide] The next shows the rectal tube in the urinary anus. The bowel has good color.

Dr. Harry Spence (Dallas, Texas): I would like to discuss Dr. Hinman's paper. I think this is a very important technique he has given us. None of us would think of making a urethra in a hypospadiac without first having corrected the downward chordee. I think in essence, he is doing the equivalent of the hypospadias straightening procedure in reverse. In other words, he is correcting the upward chordee of the epispadiac penis. I have had some experience along this same line using the Nesbit "buttonhole technique." Here a circular incision is made around the glans, cutting through the floor of the urethra, which of course lies on the dorsum of the penis, and then freeing both corpora cavernosa from the fibrotic bands which foreshorten the penis and draw it upward on erection. This gives considerable additional length to the shaft of the penis. The foreskin which lies on the undersurface of the glans in the epispadiac is devel-

oped into a single layer and the glans drawn through a buttonhole so that the foreskin comes to lie on the dorsum of the penis. This gives an abundance of pliable skin to utilize in the construction of a seminal canal later.

Dr. Hinman's operation has the additional advantage of closing the depression at the junction of the prostatic with the penile urethra. I think this is a significant contribution.

I would like to ask Dr. Hinman when he prefers to start constructing the urethra following his straightening procedure. I believe Dr. Hinman, Sr. pointed out that it is well to defer making the urethra in the epispadiac until the boy has passed puberty, because of the hazard of traumatizing the ejaculatory ducts when operating on the infant or young boy.

I was quite fascinated by Dr. Kiefer's work. I have been a little reluctant to adopt the various proposed "turning in operations" on the bladder in exstrophy in order to get away from putting the ureters into the intestines. Certainly transplanting the ureters into the sigmoid by the conventional method leaves much to be desired, but I think the same thing is true of the operations proposed to infold and reconstruct the bladder in exstrophy. With all due respect to the men doing this work, I do not believe they have solved the problem of continence which is of paramount importance. There is an old poem to the effect that "Only God can make a tree," and I think only God can make a sphincter. I do not believe that a structure at the bladder outlet represents a physiologic sphincter.

I would like to ask Dr. Kiefer if he has had rectograms made after injecting opaque dye into the rectal pouch. I am wondering about the size of the pouch as in several of his slides it seems to me the capacity was rather small. I also wonder if any ureteral reflux was noted in case he has injected dye into the pouch.

Dr. Joseph H. Kiefer (Chicago, Ill.): I will try to take these questions in order.

What Dr. Hinman says about the technical ease of this operation is true. We were surprised at how easily things went just taking them serially and in order. Dr. Hinman's pictures brought out the details very nicely.

Dr. Spence, we did some rectograms, some of them with pressure studies; call it a rectometrogram, if you will. The pressures were not high. I think the highest pressure was somewhere around 25 to 30 millimeters of mercury; the capacity was 200 cc. We did get mild reflux on one of the retrograde rectogram studies. It showed slight dilatation of the ureter. We looked into what had been published on the matter of pressure. Pressure has been proven to be much lower in the rectum when it is used as a urinary reservoir than is the defecation pressure and the peristalic pressure which develops in the rectum when it is in continuity with the bowel.

Dr. Lopez, there has been mucus in the urine, but the cell counts have not been high. We have had no difficulty up to the present time due to congealing of mucus. We have noticed a tendency to constriction of the sigmoid segment going through the anal sphincter, easily corrected by finger

dilatation. To use the advanced segment for the urine and re-anastomose the rectum to the bowel would give a less desirable situation in which the external sphincter alone must hold the urine. Regarding Dr. Hovalecque's experiment; the internal sphincter is an intrinsic part of the bowel musculature. When you put the urine in the rectum, you have action of both sphincters, while the bowel part goes through only the external sphincter. However, having to hold chiefly solid material, it can more easily do this job. Whether to bring the sigmoid behind the rectum brings up the question of the blood and nerve supply of the rectum. It is more normal as to location of the sphincters, rather than having the fecal disposal between the urethra and the vagina. We have thought that we would try it in the future.

Dr. Frank Hinman, Jr. (San Francisco, Calif.): Several answers. One is to the problem of the age of repair of the epispadias. I know my father's reason for wanting to defer it. Just recently I saw a patient done at an early age, repaired by the old Young method, who did develop stenosis in his prostatic urethra. My father went back into it to repair it and found no lumen at all. The young man was married. Every time he had intercourse, he had terrific pain in his perineum, so that every time he would take codeine. That would cause constipation and in turn would give him pyelonephritis. He was almost rendered useless as far as his wife was concerned. He gradually developed a prominence in his perineum. I marsupialized this sac, so that he now has a fistula and gets along very well. The pain no longer occurs.

We have had quite a bit of interest in the rectal bladder. Dr. Kiefer is right about the way he is going about this. Dr. Gilbert I. Smith and I studied the rectal pressures. The defecation pressure in the dog or the human being goes up to 180 or 240 cc of water. With the isolated rectum, only pressures of 30 cc were obtained. Filling the proximal loop to overdistention would still generate only an intrinsic pressure of 30 cc of water in the distal segment.

The question has been raised by Dr. Lopez whether we should use the Boyce-Vest procedure. It would have been impossible to do this. The ureteral orifices were pouted out, and they would be incompetent. Perhaps the work of Roger Baker on the anastomosis of the bladder to the large bowel, in dogs at least, showing that urethral orifices lose their competency if subjected to pressure, shows why it is not worth while to tip the bladder back. I think Dr. Goodwin's straight ureteral run is certainly the easiest thing for this particular problem.

The suggestion of putting the new loop behind the rectum, of course, is an old one. Years ago Heitz-Boyer and Hovelacque put the sigmoid loop (from which they were making their anal colostomy) behind. They resected the coccyx to do this.

Dr. John K. Lattimer (New York, N. Y.): I would like to take this opportunity to comment, too, on the exstrophy problem, in reference to ureteral reflux. We have found when we put exstrophic bladders back into the abdomen, that ureteral reflux occurs when one does a cystogram. For this reason there seems to us to be little point in trying to preserve the ureteral orifices. Dr. Robert Johnson recently reported to us his results in 18 cases where he used the rectum as

a urinary reservoir, and pulled the sigmoid down through the anal sphincter. His observations as to the usefulness and success of this operation were essentially in agreement with what has been said here by Dr. Kiefer.

Dr. Engel, we have had an exactly similar case with an allergic bladder lesion in a hyperallergic patient.

In regard to my own remarks about the treatment of patients with deficiency of abdominal musculature and dilatated urinary tracts, the first and most important step is to relieve the bladder outlet obstruction. Whether this is done by the passage of a large sound, or by transurethral resection or by open operation to remove the bladder neck obstruction, it is still the most important step. Of course, if the condition has gone on so long as to make the ureters dilate and meander severely, and if these meandering loops have become stuck together, you may have additional points of obstruction in the ureters, which may also require correction.

SEVERE ACUTE URETHRITIS FOLLOWING TRANSURETHRAL PROSTATIC RESECTION

MONTAGUE L. BOYD

From April 1956 to December 1957 I had five patients who acquired acute urethritis after transurethral resections, a complication of the operation never encountered by me previously. It is a severe inflammatory process accompanied by extensive stricture formation necessitating treatment by urethral dilatation with sounds.

On the first postoperative day there is edema of the meatus and of the glans, and at times, some edema of the prepuce. Some urethral discharge occurs about the catheter; when, on the fourth day, the catheter is removed the urethral edema, with the discharge drying at the meatus, may seal up the urethra. At the first few voidings after the removal of the catheter the urine is passed fairly well, but within twelve to twenty-four hours a definite diminution occurs in the size and force of the stream and voiding is frequent and painful. In two cases I have had to replace the urethral catheter and in two a 24F bougie à boule was tight in the urethra, its passage was painful and followed by a good deal of bleeding.

DIFFERENTIAL DIAGNOSIS

This type of urethritis should be distinguished from the ordinary slight urethritis which sometimes occurs after urethral trauma and at times, in so-called allergic patients, follows catheterization. While the severity of the inflammation in these cases varies, and at times may be marked, I have seen no subsequent stricture development.

Nor is it the urethritis which follows transurethral resection where delayed stricture formation occurs; in such cases the symptoms of acute urethritis are absent. This type of complication has happened *infrequently* in my cases of transurethral resection, and I have always thought that the strictures resulted from some localized urethritis existing prior to the operation, or to a narrowing of the meatus or of the pendulous urethra, changes which were inflammatory or congenital and were marked enough to cause inadequate circulation in the abnormal parts of the urethra during the time that the sheath of the resectoscope was in it. In none of those cases has the patient had acute urethritis symptoms and there has not been such evident trouble in voiding immediately after operation. The strictures were discovered at routine checkups of patients several weeks after operation.

The urethritis of the acute nonspecific type, not infrequently seen by urologists, where there is a more or less profuse purulent urethral discharge, is not followed by urethral strictures, and almost all of such cases have a pretty marked prostatitis and posterior urethritis from which the symptoms arise.

In the past the only strictures which I have seen following acute urethritis have been from acute gonorrheal urethritis or from the severer cases of urethritis caused by the injection of some such substance as bichloride of mercury or

1:1000 acriflavine solution (where the urethra has been kept filled with the solution even under gentle pressure for even fairly short periods)

ETIOLOGY OF ACUTE POST-TRANSURETHRAL RESECTION URETHRITIS

It can be seen from the following description of the technique which I have employed for many years for the transurethral resection operations and the methods employed for the sterilization of the genitalia and instruments, as well as the other procedures, it is unlikely that the preoperative, operative, or postoperative measures are the principal causes of the acute urethritis.

In the many years that I have been doing transurethral resections I have varied my technique very little. The Davis-Bovie electrosurgical unit (not the A.G. unit) has been used with the cutting current set at 55 or 60, rarely 65, and the McCarthy electrotome made by American Cystoscope Makers, Inc. Some years ago I began using a glass instead of bakelite sheaths and a little later melamine sheaths also. For many years all my instruments were sterilized by immersion in 10 per cent formalin solution, but for several years I have used a solution of A.C.M.I. urolocide in which the instruments and cords have been soaked for never less than one hour. As an irrigation I used sterile distilled water until about three or four years ago when I changed to cytal solution.

The Liebel-Flarsheim electrosurgical units have been thoroughly checked by a factory representative. He found nothing wrong. I tested the sheaths, which I had been using, by clipping the wire of the inactive electrode to the tip of the sheath and, with the sheath submerged, passing the active electrode along it to within three or four millimeters of the inactive electrode. There was no visible evidence of activity of the electric current.

The patients have been shaved and cleaned in their rooms, and as soon as they were put on the operating table I have tried to sterilize the urethra as far as possible by injecting 1:1000 acriflavine into the urethra a couple of times. Retention of sufficient acriflavine in the urethra to cause strictures has been prevented by careful compression along the urethra before the electrotome sheath was inserted. Tincture of zephiran solution has been used for sterilizing the skin of the penis, pubes, and scrotum. The drapes have been towels and a large sheet.

The anesthetic has usually been spinal (not a high one) reinforced when necessary by gas oxygen or pentothal sodium. The preanesthetic hypodermics have for years been seven grains of sodium luminal followed by pantopon or demerol and atropine.

The retention urethral catheters have always been sterilized by boiling for thirty to forty minutes. In the past few months they have been autoclaved at 50 pounds pressure for 15 minutes. If the urethritis has been caused by inadequate sterilization of the catheters or instruments it certainly would have appeared years ago instead of just last year.

After the fourth case of acute urethritis occurred, everything in the transurethral resection operating room was autoclaved which could be sterilized in that manner, and the room was thoroughly cleaned, sealed, and sterilized for 24 hours

with formaldehyde. But still the complication has continued in spite of these precautions, and even when, about the last of March 1957, we moved to the newly completed Piedmont Hospital, one case of acute urethritis followed a transurethral resection, and one case of severe urethritis occurred when a retention catheter was placed in the urethra of a patient following a spinal operation.

For lubrication of the electrotome I have used A.C.M.I. jel for many years, frequently removing and relubricating the sheath during the operation. The long continued use of this lubricant without acute urethritis would seem to eliminate it as a cause in my cases, and another urologist has had acute urethritis occur although he used mineral oil and vaseline for lubrication of the sheath. The inactive electrode under the patient has either been wet with water or had K.Y. jelly applied. Of course, batteries have been employed for lighting the lamps on the telescopes.

Urethral trauma resulting from the urethrotome in a narrowed urethra is not a likely cause. On all of the five patients I had passed a 28 or 29F bougie à boule easily through the meatus, and to the external sphincter, before I operated upon them and on the last patient I passed a 32F bougie à boule without encountering any resistance. In only one case was there any evidence of preoperative urethritis. That was the fourth case where the passage of a 29F bougie à boule resulted in a slight bleeding from the urethra but no sign of tightness of the urethra was found.

I have been corresponding with Dr. Hjalmar Carlson of Kansas City concerning the etiology of post-transurethral resection strictures. He stated in an Urologists' Letter Club Letter of January 10, 1955 that strictures invariably occurred as the result of using the same electrotome sheath more than 75 times and if he changed to a new sheath no strictures occurred. I cannot be sure that he and I are discussing the same complication. His letters do not seem to indicate that his patients had acute urethritis. As I have pointed out above, the usual post-transurethral resection stricture develops without all the severe symptoms which occur in these cases of acute urethritis. I have not counted the number of times that I have used my different sheaths but I am sure that they have not been used more than thirty or forty times since they were new. However, I have now only new sheaths.

For the postoperative retention catheter I used for many years a straight red rubber urethral catheter but rarely a size larger than 18F. When the Foley catheter came along I began using a 20 or 22F Foley latex catheter with a 30 cc bag, usually putting only 12 to 15 cc of water in the bag. Both Bardex and A.C.M.I. catheters were used without discrimination until the early part of 1956.

The trauma from the postoperative retention catheters in my cases has been the same for years without producing a single case of acute urethritis. In the first case having this acute urethritis a 22F "Wheeler" (Bardex) Foley catheter was used. Immediately after that I began using the new A.C.M.I. Foley catheter (which was put on the market at about that time) because of the reaction with the Wheeler catheter and because the new A.C.M.I. catheter had a much larger lumen than any of the other Foley catheters. Although we began using the new A.C.M.I. catheters exclusively at the Piedmont Hospital it must be noted that

the urethritis did not always occur following transurethral resection, nor did it occur in any of my nonoperative cases where retention catheters were used. However, I have been told (personal communication)* that a neurosurgeon had several cases of rather severe acute urethritis from using a retention catheter after spinal operations, and only a month ago I saw one such case 24 hours after an A.C.M.I. catheter had been inserted in which there was edema of the meatus, the glans, and the prepuce.

Another urologist† had two cases of acute urethritis where the same make of retention catheters were used, one following a retropubic bladder operation and the other after operation on a perineal abscess. In early April 1957 he performed two transurethral resections the same day, using a Bardex Foley in one case and an A.C.M.I. in the other; the patient who had the A.C.M.I. catheter had acute urethritis. He has had altogether seven or eight cases, most of them after transurethral resections.

To test for skin sensitivity to the catheters I cut small pieces of both Bardex and A.C.M.I. catheters and fastened them to the inner thighs in two of the patients who had had acute urethritis. The pieces were covered with adhesive plaster, which in turn was covered with collodion, and they were left on four days on one patient and six or seven on the other, without the slightest sign of redness under the rubber.

I have talked with Mr. Kleine, the American Cystoscope Makers, Inc. representative in our territory, and recently to Mr. Frederick J. Wallace. They both tell me that they make their own catheters at A.C.M.I. and have in no way changed the composition of the rubber in the catheter and, furthermore, that A.C.M.I. has had no report from anyone else concerning urethritis from the catheters although they have sold many hundred catheters. I do not see, in consideration of this information, how it could be the type of catheter which is the causative factor.

On December 27, 1956 I made a report of the occurrence of this complication in an Urologists' Correspondence Club Letter, and I have had only two replies, one from an urologist who had seen only one case and another‡ from an urologist who reported that five of his cases had this type of urethritis, four after transurethral resections and one after a suprapubic prostatectomy. He writes me that the retention catheters were latex Foley catheters made by A.C.M.I.

It seems improbable that the acute urethritis results from a sensitivity to any of the antibiotics. The third and fifth of these five cases had no sensitivity to drugs. The first and fourth had had skin eruptions from penicillin but received none at or after operation; the second case had a history of skin eruption from sulfonamides and, of course, was given none. All of the patients received some antibiotics after operation: case 1, terramycin and chloromycetin; case 2, combiotic, furadantin, and mysteclin at different times; case 3, combiotic and chloromycetin; case 4, chloromycetin; case 5, mysteclin. In none of the patients

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was there evidence of skin eruption or gastrointestinal upset, except in the first case where the dermatitis on the hands had been present before operation.

Cultures of the urethral discharge were unfortunately not made. Perhaps something could be learned from cultures although the urethral discharge was not profuse. Protecting the meatus from contamination by sterile dressings put on over the glans penis at the end of the operation might offer a better chance of getting an uncontaminated culture. Accurate determination of the kind of organism found in the urethra after the catheter is removed is made difficult because all patients having retention catheters after transurethral resection have, invariably, infected bladders in spite of the administration of chemotherapeutics and antibiotics; so that when the catheter is removed and the patient voids, the urethra is, of course, contaminated by the bacteria in the urine and, with the stricture formation which is present, there is a tendency for the retention of urine in the urethra to exist.

CASE REPORTS

Case 1. The first patient having this complication of acute urethritis was W. H. M. (Piedmont Hospital No. 163599) 57, married. He had been treated for some years for an "allergic" dermatitis on his hands, which was still present, and there was a history of his having had a skin eruption from penicillin. He had a benign prostatic hyperplasia and also a chronic prostatitis and a 22F "Wheeler" (Bardex) Foley retention catheter was used. On the first and second postoperative days he had elevation of temperature to 101 (which is in my experience unusual for transurethral patients) but none thereafter. As this was the first time I had ever seen the complication of severe acute urethritis I thought it was an allergic reaction and requested his general medical doctor to start treating him for allergy. He had a good deal of discomfort on voiding and did not void very well. He went home on the sixth postoperative day, but had so much trouble that he came back the same day, and I found that an 18F catheter was tight in the pendulous urethra and that the residual urine was 300 cc. He improved slowly and went home again on the twelfth day. The urethra subsequently was gradually dilated with sounds, at increasingly longer intervals, to 32F for about four months.

Case 2. J. J. J. (Piedmont Hospital No. 165032) aged 52, married, had a long standing bladder neck obstruction due essentially, I believe, to chronic prostatitis and perhaps some congenital bladder neck changes, and he also had some early benign prostatic hypertrophy. I had treated him earlier for chronic prostatitis and chronic seminal vesiculitis. He had little or no postoperative fever and his postoperative history was much the same as the others.

Case 3. J. M. F., aged 61, married (Piedmont Hospital No. 167705), had early benign prostatic hypertrophy, and elevation of temperature after operation to 99.8F at most for a couple of days, and his postoperative history was much the same as the others.

Case 4. T. C. L., 75, widowed (Piedmont Hospital No. 168313), had a bladder neck fixation due seemingly to chronic prostatitis, and a small benign prostatic

hypertrophy. The bladder neck elevation and fixation made it difficult to pass the sheath of the electrotome. Microscopic sections of the resected tissue showed a very few quite small areas of carcinoma (confirmed by the Armed Forces Institute of Pathology). He had no postoperative elevation of temperature but the urethral obstruction, following the removal of the retention catheter, was the most marked of any of the cases. Voiding was frequent, difficult, and painful. Instrumentation without general anesthesia was almost unbearable. The catheter was replaced several times for one, two, or three days at a time. Subsequently, since I had to administer a general anesthetic to dilate his urethra, I did an internal urethrotomy (about three months after the transurethral resection). He has been taking stilbestrol continuously since the carcinoma was reported to have been found.

Since endoscopy, cystoscopy, and rectal palpation at the time of the internal urethrotomy showed no further evidence of carcinoma I sent him, for the sake of thoroughness, to Dr. Charles Higgins for consultation. At the Cleveland Clinic a transurethral biopsy of the bladder neck and remaining prostate tissues was done without discovering any carcinoma.

Case 5. H. J. D., 59, married (Piedmont Hospital No. 168820), was operated upon December 21, 1956. He was a man upon whom I had done a transurethral resection in July 1948. He returned in 1956 with chronic prostatitis, which was very resistant to treatment and, also, a recurrent benign prostatic hypertrophy. Before the transurethral resection a 32F bougie à boule was passed quite easily through the urethra.

He had elevation of temperature to 100F the day of and the day after operation, and a great deal of pain from the acute urethritis. But I think that he was more sensitive to pain than usual. I had to dilate his urethra under a general anesthetic a number of times, after which he seemed quite well.

CONCLUSIONS

Five cases are reported of severe acute urethritis following transurethral resection. There is almost immediate visible edema of the meatus and even in some cases of the glans and of the skin about the coronary sulcus. Urination becomes painful and difficult once the retention catheter is removed and the caliber of the urethra is considerably reduced. All the patients have acquired extensive fibrous strictures of the pendulous urethra which have required months of urethral dilatation with sounds.

Careful consideration of most, if not all, of the causes for such a complication is discussed without any conclusion being reached as to the etiology.

It is made clear that this is a severe complication which should receive serious consideration if evidence of its continued occurrence accumulates.

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HORMONE-INDEPENDENT CANCER OF THE PROSTATE

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It is common knowledge that certain cases of prostatic cancer do not respond to hormone therapy in the usual way. Woodard and Dean in 1947, for example, found approximately ten per cent of such cases in their series. While we believe the average incidence to be somewhat less than this, these refractory tumors present such difficult problems when they do occur that further study of their nature and behavior seems of interest. The following three cases observed during the past two years form the basis of the present discussion.

CASE REPORTS

Case 1. N. E. Deaconess Hospital No. 70322. A 71-year-old man was admitted to the New England Deaconess Hospital for the first time on February 26, 1956 because of pain in his low back, right groin and right hip which began in July 1955 and became progressively severe over the ensuing months. In September 1955 a transurethral resection of the prostate had been performed elsewhere because of difficulty with voiding, hesitance and dysuria. A histologic diagnosis of adenocarcinoma of the prostate gland was made and therapy with stilbestrol, 1 mg. qd. was instituted. Despite hormonal therapy the pain continued to become progressively worse and the patient lost 30 pounds in weight.

On examination he was found to be in a generally good physical state. Some enlargement of the liver was present to two finger breadths below the costal margin. Tenderness was noted in the right groin and over the right ascending pubic ramus. Rectal examination revealed an extensive, hard, irregular area in the region of the prostate gland consistent with carcinoma. Routine laboratory studies were within normal limits save for 20–25 white blood cells in the urine. Acid phosphatase determination was 0.18 Bodansky units. The lung fields were clear. X-rays revealed compression of vertebrae D-6 and L-1 with osteolytic changes in the bone possibly related to metastatic carcinoma of the prostate but not typical in appearance. X-ray films of the lumbar spine and pelvis were otherwise negative. A total of 1500 r of x-ray therapy was given to the involved areas of the spine from March 1 to March 15, 1956 because of the equivocal appearance of the x-rays. Bilateral orchiectomy was performed on March 7. The patient took stilbestrol, 10 mg. a day, during the first ten days of his hospital stay and then 1 mg. a day thereafter. At the time of his discharge, March 25, 1956, he was somewhat better but still complained of discomfort in the region of the right groin. Estrogen therapy was continued.

The patient continued to have pain at home but showed some improvement for a few months, though the mass in the prostate remained large and quite firm. When he was seen in October 1956, pain had again become a severe problem. He took meticorten, 10 mg. three times a day, for a short period without relief. X-ray therapy was again employed, a dose of 2100 r in air being given to the D-11, L-4 area of the spine and 1500 r in air to the right groin. Some temporary benefit

followed this treatment, but pain soon recurred and became intractable. He returned to the New England Deaconess Hospital on February 11, 1957, less than one year after orchiectomy. At this time an x-ray film of the pelvis revealed diffuse osteoblastic metastases typical of prostatic carcinoma. The serum acid phosphatase determination was 9.9 Bodansky units and the hemoglobin 11.2 gm. per cent. The prostate gland was large, hard and irregular, apparently without definite change since the previous examination. Bilateral cervical chordotomy was advised and carried out in stages on February 15 and February 21, 1957. Prompt relief of pain followed. In the hope that there might be some control of of this rapidly spreading process, stilphostrol was prescribed, 100 mg., intramuscularly, daily. One month later the serum acid phosphatase was 1.79 Bodansky units and the alkaline phosphatase 13.3 Bodansky units. He was discharged home on March 31, 1957 to continue taking stilphostrol by mouth, 100 mg. per day.

Here, then, we have a patient with apparently typical adenocarcinoma of the prostate which never showed the usual response to hormonal treatment and was associated with uncontrollable pain, severe enough to require chordotomy, 19 months after the onset of symptoms.

Case 2. New England Deaconess Hospital No. 65884. A business executive, aged 70, was first seen in consultation on September 13, 1955. He had had increased frequency of urination for 1 year and a few months previously, in another hospital, had had a suprapubic operation for the removal of bladder stones. The surgeon decided to remove the prostate at the same time because it was quite large, but he found the gland to be malignant and complete enucleation was impossible. When we first saw the patient, his wound was well healed and he had no symptoms. He had been taking stilbestrol for about 3 months. The general condition was excellent. Cystoscopic examination found the bladder to be negative; no tumor was to be seen and no significant prostatic obstruction. Rectal examination found a firm plaque in the region of the prostate, too extensive for surgical removal. The serum acid phosphatase was normal. No metastases were seen in x-ray films of the chest, lumbar spine and pelvis. The original slides were reviewed by Dr. Warren who made the diagnosis of "undifferentiated carcinoma, more malignant than usual carcinoma of prostatic origin." A bilateral orchiectomy was performed and the patient left the hospital October 4, 1955. Later as an outpatient, he received 28 x-ray treatments with 2 million volts and rotation of the pelvis with a port measuring 10 cm. in diameter. The calculated dose in the bladder was 4412r. Estrogen therapy was continued.

The patient returned to the hospital in January 1956, because of pyelonephritis and renal colic due to a small uric acid stone. There were no x-ray signs of metastases. The serum acid phosphatase was normal. He was leading an active life but, in the succeeding months, there was some evidence on office examination that the hard mass in the region of the prostate was becoming more extensive. He re-entered the hospital in October 1956 with acute urinary retention and a transurethral resection was required. There were no signs of metastases and the serum acid phosphatase determination was .6 Bodansky units. At the time of the

resection, no actual tumor could be seen but quite marked obstruction at the bladder neck was present. The tissue removed showed carcinoma, unclassified.

Retention soon recurred and transurethral resection was repeated on December 5, 1956. The tissue removed at this time was again described as undifferentiated carcinoma. Thrombophlebitis of the right leg and hematuria on dicumarol therapy brought the patient back to the hospital three weeks later, but nothing more than brief catheter drainage was required. The serum acid phosphatase determination was normal. He became progressively weaker and he complained of persistent discomfort on urination. A large mass was present in the region of the prostate and bladder. Thrombophlebitis developed in the left leg and left arm. X-ray film of the chest and pelvis on March 4, 1957 showed no evidence of metastatic tumor. Estrogen therapy was continued together with meticorten. The serum acid phosphatase on April 1, 1956 was 3.0 Bodansky units and the serum alkaline phosphatase was 5.2 Bodansky units. On April 12, 1957, less than two years from the time of prostatectomy, a permanent suprapubic cystotomy became necessary. Exploration through the open bladder found practically complete obstruction at the bladder neck with extension of the mass in this region upwards on the right side, beginning to encroach upon the bladder cavity and probably occluding the right ureter.

This patient had a highly undifferentiated carcinoma whose site of origin might well be in doubt, if the diagnosis depended upon examination of the histologic sections alone. However, the clinical behavior of the neoplasm associated with a late elevation of the serum acid phosphatase allows it to be classified as tumor derived from prostate and not from bladder or urethra. The metastases that he must surely have are lymphatic, since they have not appeared in the usual areas. The slow rise in serum acid phosphatase, despite a large amount of gross tumor, is probably in keeping with the poor differentiation of the lesion, since it is known that immature prostatic tissue produces only very small amounts of acid phosphatase.

Case 3. Carney Hospital No. 56-458. This case will be reported in greater detail because it illustrates so well the problem under discussion.

A clergyman aged 53, unmarried, was admitted to the Carney Hospital, November 29, 1955. He complained of burning discomfort on urination with increased frequency, and tenderness in the region of the left hip. He had noted these bladder symptoms intermittently and with occasional diminution of the urinary stream during the previous few years. Two years before, he had seen a few spots of blood on his underwear and this had recurred once recently. Seven weeks before admission, he fell and injured his back and tenderness persisted in the left hip. There was no familial history of cancer.

Physical examination found a well developed and well nourished man of 53 whose vital signs were normal. The initial study was negative except for tenderness on deep palpation in the left hip region. The urine showed 20–25 red blood cells and 4–6 white blood cells in the sediment. The reports of blood counts and blood chemistry were normal. The serum acid phosphatase was 1.2 King units. The alkaline phosphatase was 4.6 Bodansky units.

The lung fields were clear by x-ray. Films of the pelvis and left hip showed only soft tissue calcification at the margin of the greater trochanter of the left femur. Intravenous pyelograms were normal except for some elevation of the floor of the bladder consistent with enlargement of the prostate.

When first seen in urological consultation on December 6, 1955, the patient had no urinary symptoms. The prostate was of normal size on rectal examination; it was firm and uneven with ill-defined upper limits. The changes were thought to be suggestive of prostatitis rather than tumor.

Cystoscopy found no residual urine. There was edema of the distal trigone. Around the outlet of the bladder in the internal sphincter margin and, to some extent, in the immediately adjacent bladder mucosa, were multiple hemorrhagic areas which might well have been the source of bleeding and which now would suggest an inflammatory process in the underlying prostate. In the bladder, some of these areas were slightly suggestive of interstitial cystitis. There were shreds of adherent fibrin and one or two small, white nodules like pustules. There was no significant obstruction to be seen at the bladder neck or within the prostatic urethra. Rectal examination with the patient relaxed under spinal anesthesia found questionable thickening in the seminal vesical region with no suggestion of tumor. The prostate was slightly enlarged and uneven in consistency and in some areas a little firm, but the gland appeared to be confined within its capsule and it was thought that the changes were probably due to prostatitis. A program of antiseptic medication was ordered, but it was noted that the prostate should be kept under observation by means of occasional office visits.

The clinical response to treatment was not convincing. The patient still reported slight burning on urination and some dribbling after voiding. The cystoscopic examination was repeated four days later. The instrument passed very easily through a soft and flexible bladder neck. The signs of inflammation were less marked. There was still no prostatic obstruction to be seen and no tumor, but, in the outlet of the bladder in the right lower quadrant, there was a slight, pale elevation which was chosen as a site for biopsy. One segment of tissue was removed with the resectoscope. The pathological report was as follows: "Portions of prostate and urethra. One fragment of prostate is free from tumor. The remaining fragments, most of which include urethra, are involved by carcinoma which grows in sheets and nests, with anaplastic cells and mitotic figures, the cells being rather plump with pink-staining cytoplasm and resembling squamous or transitional type cells. The tumor is growing in endothelial lined spaces. There is an accompanying nonspecific chronic inflammatory reaction. This type of tumor could be primary in the urethra or in the urinary bladder." After consultation with Dr. Warren, the diagnosis was made of carcinoma simplex of the prostate with epidermoid characteristics as shown in figure 1.

Stilbestrol, 10 mg. intramuscularly, was prescribed daily, and the patient was discharged from the hospital December 20, 1955, to continue on estrogen therapy and to permit the healing of his bladder neck before surgery. He returned on January 6, 1956. Dysuria and dribbling were less. The slight discomfort in the left sacroiliac region, which had been thought to be unrelated to the prostate,

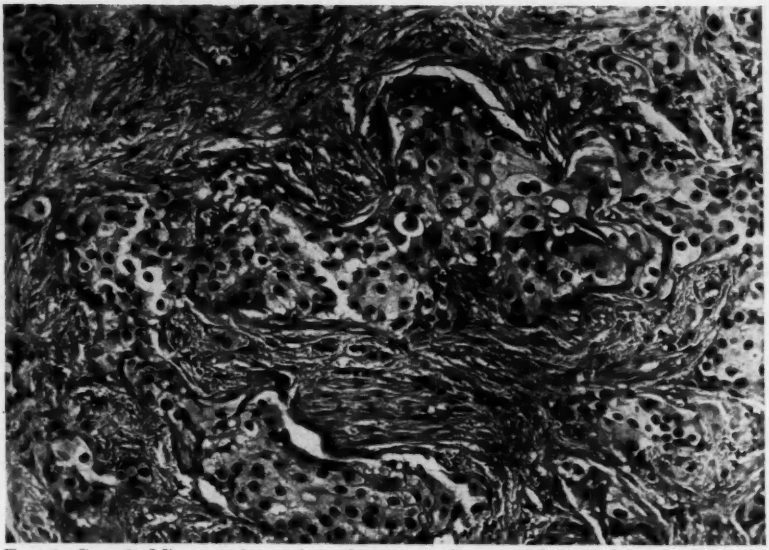

FIG. 1. Case 3. Microscopic section of prostate shows carcinoma simplex with epidermoid characteristics. ×260

was better. The gland was still small but now smooth and less firm. The serum acid phosphatase was 1.3 King units. The hemoglobin had dropped from an initial 15 gm. to 13.5 gm. The urine showed 30–35 red blood cells. No metastases were seen in the x-ray films of the lumbosacral region. Total perineal prostatectomy was advised and was planned for two weeks later, after continued estrogen therapy.

The patient returned to the hospital January 17, 1956. He had seen blood in the urine on one recent occasion. In spite of the usual dosage of stilbestrol, his back pain had become progressively worse. X-rays of the pelvic bones, which had been thought to be negative less than two months before, now showed definite osteoplastic metastases in the ilium on each side, and in the upper femur on the left side, and in the first lumbar vertebra. These were quite consistent in their appearance with rapidly spreading carcinoma of the prostate. The rectal examination still found a small prostate well within normal limits of size and without definite changes that would indicate the presence of tumor. The plan for total perineal prostatectomy was abandoned and bilateral orchiectomy was performed on January 20, 1956. At this time the serum acid phosphatase was 2.9 King units. One week later, with his backache still unrelieved, the patient was transferred to the New England Deaconess Hospital for x-ray therapy.

At the Deaconess, Dr. J. Hartwell Harrison saw the patient in consultation; estrogens were continued and meticorten was added to the program. Prior to administration of meticorten, control values of 24-hour urinary 17-hydroxycorticoids and 17-ketosteroids were 4.4 mg. and 18.2 mg. respectively. One week after treatment was started the 17-hydroxycorticoids were 6.1 mg./24° and the 17-

FIG. 2. Case 3. X-ray of lumbar spine and pelvis shows diffuse osteoblastic metastases

ketosteroids were 4.9 mg./24°. The serum acid phosphatase determination was .4 Bodansky units and the alkaline phosphatase was 22.7 Bodansky units. X-ray examination found the lungs to be clear but there were osteoblastic metastases in all of the ribs and in the clavicles and in all of the bones of the spine and the pelvis (fig. 2). There was definite increase in the extent of disease since the previous films of only four weeks earlier. Six x-ray treatments with a total airdose of 1500r were given to a single port directed into the left side of the pelvis with 2 million volt equipment. The patient was discharged home February 18, 1956, at which time the acid phosphatase determination was .2 Bodansky units and the alkaline phosphatase 17.1 Bodansky units. Final diagnosis: Epidermoid carcinoma of prostate with metastases.

Pain persisted requiring opiates and in spite of continued estrogen and meticorten therapy, he died in July 1956, within ten months of the beginning of his illness.

Insufficient data exist with regard to the epidermoid tumors, because of their rarity, as to whether or not they are uniformly resistant to hormonal therapy. In the case at hand there appears to be an association between resistance to hormonal therapy and the epidermoid differentiation.

In our experience epidermoid carcinoma of the prostate is a rare lesion. While a number of cases have been reported in the literature, most of these fail to give data as to the hormonal response of the tumors. However, two of the three cases reported by J. C. Sieracki in 1955 were noted to be poorly responsive to hormonal therapy.

The Mayo Clinic experience seems to be along the same lines. Thompson,

Albers and Broders (1953) believe hormonal therapy to be ineffective in tumors of this type.

There has been considerable speculation as to the type cell from which these epidermoid carcinomas arise. In general, it is felt that the tumors do not arise from metaplastic epithelium but rather arise from undifferentiated cells residual from the primitive embryonic outpocketings of the urethral mucosa that form the prostate in the adult. We agree with the general line of reasoning proposed by R. A. Willis (1950) in his discussion of the origin of this form of prostatic carcinoma. These epidermoid carcinomas are frequently very poorly differentiated and anaplastic in type. The squamous metaplasia seen in the prostatic ducts and acini that follows estrogenic therapy is of a different type, being noninvasive and rather uniform.

DISCUSSION

It is indeed fortunate, and perhaps somewhat surprising (in comparison with other tumors) that so many prostatic neoplasms are dependent upon androgen for continued growth. Maturity of cell structure in general appears to be essential for the normal response of a glandular structure to its trophic hormone as, for example, in the case of adrenal tumors. Most prostatic tumors appear to have some of the characteristics of adult tissue and this probably accounts for their commonly observed hormone dependence. In spite of this observation, it has not been possible in the past to establish a definite correlation between histologic appearance of prostatic tumor and response to hormonal therapy (Foot, Humphreys and Coats, 1950). However, as far as we can determine, the very undifferentiated tumors, especially those of the epidermoid type, do not respond to estrogen therapy and orchiectomy.

The group of tumors reported here represents a spectrum of tumor growth proceeding from partial differentiation to complete immaturity of cell type. Each neoplasm in this small series, though different in histology, shares a general unresponsiveness to changes in the hormonal environment, although in the first case, lowering of the serum acid phosphatase after use of stilphostrol may indicate some biochemical response. In the third case presented, it is to be noted that a normal total urinary 17-ketosteroid value was present after orchiectomy and that during meticorten administration the value was markedly reduced, suggesting a suppression of adrenal androgen supply. Obviously in this case, suppression of adrenal activity was of no aid in relieving the patient.

The in vitro observation of Lemon, Wotiz and Robitscher (1953) that, in general, slices of prostatic carcinoma destroy greater amounts of testosterone than do normal prostatic tissue slices, suggests a greater androgen requirement of tumor tissue and implies a greater sensitivity to withdrawal of male hormone. Huggins has shown that androgen can hasten the progression of prostatic carcinoma. The increased ability of tumor cells to metabolize testosterone may be in part a manifestation of increased metabolic activity rather than increased biologic need. One very immature tumor reported in Lemon's series showed no measurable destruction of testosterone. The third case in our series, representing an epidermoid lesion, may be of a similar type.

The production of acid phosphatase by the prostate gland is a secondary sex characteristic according to Huggins. Immature prostatic tissue contains very little acid phosphatase and it is not until after puberty that the normal adult tissue level is attained, representing a several hundred-fold increase in concentration. The production of acid phosphatase is therefore an attribute of adult tissue and may be used in comparing various prostatic cancers. The level of serum acid phosphatase appears to correlate with the degree of tumor differentiation in that patients with undifferentiated or immature lesions tend to have a low value. Serum and tissue phosphatase measurements are not necessarily proportional to one another in a given patient. Normal adult prostatic tissue has about twenty times as much acid phosphatase per gram as the average tumor (Huggins, 1946–47) and yet very little of this substance is detectable in the blood. Though we do not have much direct evidence to support the idea, it seems that the immature types of tumor, as well as the immature normal prostate gland, produce very small amounts of acid phosphatase (Sullivan, Gutman and Gutman, 1942).

The response to estrogen and orchiectomy following obvious metastases is not usually as definite or as prolonged as it is in more localized lesions (Nesbit and Baum, 1950). The fact that a metastasis can grow in a new area away from the parent tumor suggests a basic change in the tumor cells toward more independent behavior and greater growth potentiality.

As yet no clear physiological or biochemical difference has been demonstrated between the normal male and the male with prostatic carcinoma. Whether the endocrine changes that take place in man during the process of aging have any bearing on the production of prostate cancer cannot be discerned. At the time of life when prostatic carcinoma is most common the endogenous supply of androgen has already become greatly reduced (Hamburger, Halvorsen and Pedersen, 1945). It is obvious that a more concentrated study of the individual patient and his tumor is needed to bring further light on these problems.

It is important to recognize the fact that certain patients do not respond to androgen removal or suppression and that demonstration of initial hormone dependence does not insure a continuing beneficial response. Since the result of hormonal treatment cannot be predicted with assurance, surgical removal of prostatic tumors should be accomplished whenever possible.

SUMMARY

A small group of prostatic tumors representing the minority which show no initial response to hormonal therapy is reported.

These neoplasms are often undifferentiated in type.

As yet, no definite pattern of hormonal change has been seen in patients with carcinoma of the prostate gland and yet more careful scrutiny of the individual patient may be extremely revealing.

Finally, it is strongly urged that hormonal therapy should not be substituted for total prostatectomy, in the treatment of carcinoma of the prostate, when conditions are favorable for surgical extirpation of the disease.

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SURGICAL CORRECTION OF HYPOSPADIAS

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The ideal operation for correction of hypospadias remains as elusive today as it was in 1837 when Diffenbach allegedly first tried to correct this anomaly and failed. Innumerable surgical procedures have been advocated since then but each has been found to have its respective shortcomings. Since different surgeons do not achieve comparable results with the same techniques, it is unlikely that any therapeutic plan will ever attain universal favor. This report is a review of personal experiences in the management of hypospadias and associated deformities during a period of 6½ years.

CHORDEE AND ALLIED INITIAL PROBLEMS IN 172 CASES

From August 1950, to February 1957, 172 patients were operated on because of chordee, hypospadias or the sequelae of previous surgical procedures. When first seen, these 172 individuals did not present the same problem and did not require identical treatment. Chordee was present in 107 cases and absent in 65. Seven basic categories were represented.

1. Meatal stenosis without chordee (14 cases). It is generally agreed that mild hypospadias without chordee should not be disturbed during childhood and rarely requires surgical treatment in adult life. One notable exception is the patient with a minute urethral meatus and a poor urinary stream. Meatotomy is indicated, but if this is performed in the usual manner valuable urethra will be sacrificed and the degree of hypospadias will be aggravated.

These patients invariably have a more distal opening or indentation which on probing is found to communicate with another channel (fig. 1). This is a separate, short, vestigial, terminal urethra which lies parallel to the one through which the urine passes. If the intervening septum is divided, the caliber of the meatus can be increased without sacrificing any of the normal urethra. This type of meatotomy sufficed in 14 instances.

2. Untreated chordee and hypospadias (83 cases). More extensive surgical intervention becomes mandatory when there is any significant curvature of the penis, irrespective of the location of the urethral meatus. Many techniques have been devised for correction of chordee. These vary chiefly with the manner in which the hooded prepuce is diverted to the ventral surface of the penis. It matters little as to how the skin is revised so long as *all* of the constrictions along the corpora cavernosa are eliminated. Duplay's original operation (fig. 2) remains the simplest and was employed in most of the 83 cases of untreated chordee with hypospadias.

The urethral meatus is left intact. Thorough excision of all constricting fibrous bands is preferred even though some authors insist that they need only be di-

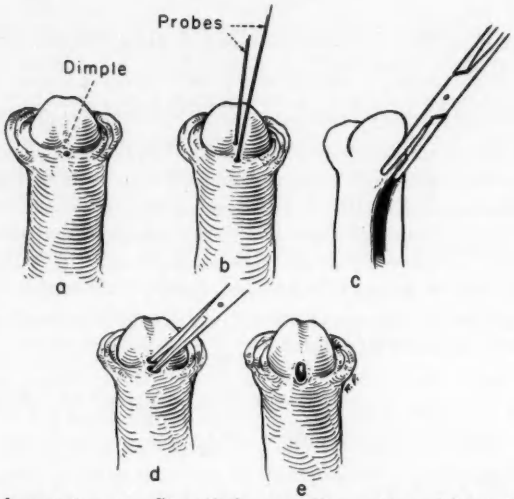

FIG. 1. Special meatotomy. *a*, Stenotic hypospadiac meatus without chordee. *b*, Dimple on glans communicates with separate short channel parallel to normal urethra. *c*, Intervening septum is crushed with small hemostat and (*d*) divided with scissors, thereby enlarging meatus (*e*) without aggravating mild hypospadias.

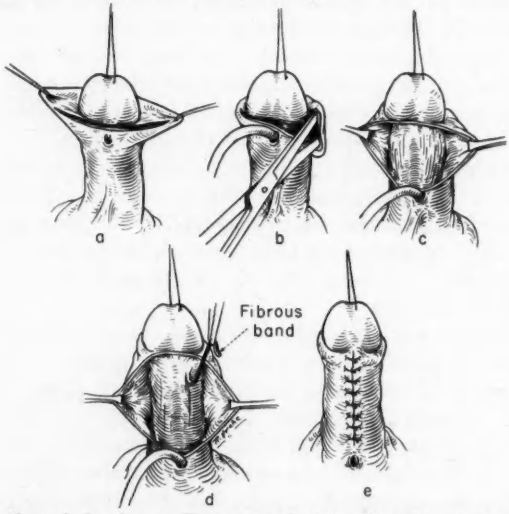

FIG. 2. Correction of chordee. *a*, Transverse incision distal to meatus is extended into hooded prepuce and (*b*) latter is freed with blunt scissors. *c*, Urethra is freed from corpora with an indwelling catheter as a guide. *d*, All constricting tissue is excised after freeing penile skin laterally. Meatus gravitates to most convenient position—usually near penoscrotal juncture. *e*, Penile skin is closed longitudinally with interrupted sutures.

vided. When the skin is closed longitudinally special precautions should be taken to avoid obliterating the furrow on the base of the glans, for this permits construction of a more desirable type of meatus during the subsequent urethroplasty. If such a furrow does not exist, an attempt should be made to create one at the time of the straightening.

If urethroplasty is contemplated within the next year, it is advisable to suture the skin with fine wire because it produces a minimum of fibrosis. If three or four years may elapse before the next stage, fine catgut suture may be used for closure of the skin. An elastoplast dressing is applied to prevent edema, but the displaced meatus is left exposed.

An indwelling catheter is employed for 24 to 48 hours in patients of school age. The catheter is removed at the end of the operation in younger patients, since postoperative urinary retention is rare in those less than six years of age.

There will be less subsequent edema if the dressing is not disturbed until the eighth to tenth day, at which time wire sutures are also removed. Thiopental (pentothal) sodium by rectum provides excellent analgesia for the very young patients.

3. Unsuccessful correction of chordee (12 cases). Twelve patients still had considerable chordee despite from one to five previous operations. The author had to operate twice on one patient with chordee before the penis appeared straight. Since failure may occur with any method, correction of chordee should not be combined with the definitive type of urethroplasty but should be a separate procedure.

Fortunately, most of the patients in this group that required further straightening still had ample penile skin and some degree of hooded prepuce. In these patients the condition was corrected by the previously described method. But when the prepucial skin already had been diverted to the ventral surface or had been removed by circumcision (as was true in four cases in this series), some form of the well-known Z-plasty had to be employed.

4. Chordee without hypospadias (five cases). Five patients had marked chordee but the urethral meatus was in normal position at the tip of the glans. Although it has been reported that adequate straightening in such cases may result from merely freeing the urethra and providing more ventral skin, this was not true in this group. In each of these five cases the urethra was much too short and had to be divided.

To assure preservation of the terminal segment it is best to transect the urethra in the vicinity of the penoscrotal juncture rather than near the glans. The distal portion is freed, all constricting tissue is excised and additional ventral skin is provided by right-angled incisions into the prepuce or by appropriate Z-plasty.

An indwelling catheter is left in both segments of the urethra for approximately one week to prevent stenosis of the distal urethral opening as well as of the new hypospadiac meatus. Additional urethra is constructed at a subsequent procedure to bridge the gap between the two urethral segments.

5. Urethroplasty despite residual chordee (seven cases). The most unfortunate individuals were the seven who had urethroplasties before their chordee had been eliminated completely. One of these patients had been subjected to 10 operations. In three cases the reconstructed urethra was intact and had to be transected as in the preceding group. Varying amounts of new urethra had to be sacrificed in the other four cases because of fistulas. In most instances the patient literally had to start anew.

Pathetic situations of this type emphasize most dramatically the importance of being certain that chordee has been corrected. These tragedies can be avoided only by truly honest evaluation of postoperative results.

6. Hypospadias without chordee (33 cases). Five patients had sufficient hypospadias to need surgical treatment despite the fact that they had never had any chordee. The old type of urethral meatotomy was responsible for at least three of these.

The other 28 patients had been treated successfully for chordee but no attempt had been made to construct the additional urethra. Six of these individuals had required more than one straightening operation. Eighteen patients had had their chordee corrected by the two-stage Edmunds operation. The remaining 10 penises had been straightened in a variety of ways but most of the procedures were variations of the Heineke-Mikulicz principle with the exception of Nesbit's operation. The latter has come into favor because it provides a transverse closure at the base of the penis and avoids longitudinal scarring.

7. Postoperative urinary fistulas (18 cases). In 18 cases the chordee had been corrected and one or more attempts had been made to construct additional urethra. One patient had had nine previous operations. All of these 18 patients had at least one fistula. They varied in size from 1 mm. to that of most of the pendulous urethra. Some also had urethral strictures.

It was impossible to be certain of the type of urethroplasty that had been employed in each case. But they are known to have included free tube grafts, and Ombrédanne, Thiersch-Duplay, Denis Browne and Cecil operations.

Comment. There is overwhelming evidence that the straightening operation is not viewed with sufficient respect in some circles. Frequently the procedure is much too conservative. The original attempt to correct chordee had failed in 19 per cent of the patients in this study. Some surgeons who never intend to perform urethroplasties unhesitatingly attempt the straightening. Frequently too much skin is diverted to the ventrum for some types of urethroplasty. Best results will be achieved when the entire surgical plan is properly integrated and each operation provides appropriate preparations for the next stage.

Opinions differ regarding the ideal age for correction of chordee, but most writers agree that the penis should be straightened early in life. In the present series chordee was corrected at ages that varied from one to 30 years. Twenty-five of 107 patients were operated on successfully for chordee when they were less than 2 years old. Operations during infancy require more meticulous dissection but are less formidable than in the older age groups. The ideal time seems to be around 18 months of age but most of the patients are not seen until they are much older.

After all chordee had been corrected in 140 candidates for primary urethroplasty the urethral meatus was at the penoscrotal juncture in 45.7 per cent, on the penile shaft in 25 per cent, in the scrotum in 20 per cent and remained on the perineum in the other 9.3 per cent.

PROVISION OF NORMAL FUNCTION IN 105 CASES

The calculated risk of fistulas, strictures, poorly draining pouches, hairballs, maldirected streams and grotesque deformities must be appraised factually and realistically when one is choosing from the various types of urethroplasty that are still in vogue. The desirability of any operation is qualified further by the complexity of the procedure, the number of stages that it entails, its adaptability to the different problems that may be encountered, the age at which it is most feasible and the type of functional and cosmetic result that it usually produces. Personal prejudices unquestionably have colored all attempts to weigh the relative importance of each of these factors.

Opinions are especially sharply divided regarding the importance of constructing a glandular segment of urethra. Perfectionists have been most insistent that the new meatus be at the tip of the glans. Only free or pedicle tube grafts have been capable of providing this with any consistency. Deliberate termination of the new urethra on the base of the glans may lack cosmetic appeal but it need not be a functional handicap and it avoids operating in an especially treacherous region.

It is generally agreed that there should be an interval of at least six months between correction of chordee and urethroplasty, but there is no unanimity of opinion regarding the ideal age for construction of the new urethra. Many surgeons readily admit the desirability of correcting hypospadias during the preschool period but question the practicality of plastic operations at that age because of the size of the phallus. Treatment in the current series was based on the personal conviction that it is the inalienable right of every boy to be a "pointer" instead of a "sitter" by the time he starts to school.

It is unlikely that any one procedure will suffice or offer optimal results in all cases. Of 117 patients in this series who underwent urethroplasty, 105 need no further treatment. They conformed to three therapeutic categories, each of which was managed somewhat differently. These categories consisted of 1) 63 patients who had their meatus at or distal to the penoscrotal juncture, 2) 21 patients who had scrotal or perineal hypospadias and 3) 21 patients who had fistulas of varying size and number after unsuccessful urethroplasties prior to admission.

1. Penile and penoscrotal hypospadias (63 cases). All untreated penile or penoscrotal hypospadias was treated by a version of the Cecil method.

First stage: When the meatus is at or just beyond the penoscrotal juncture, the technique shown in figure 3 is employed. The parallel incisions are joined near the posterior edge of the meatus to avoid difficulty inverting the skin at that point. They are not extended onto the glans until the terminal urethra is ready to be constructed. The width of the medial strip of skin must be sufficient to provide a tube of approximately the same diameter as the existing

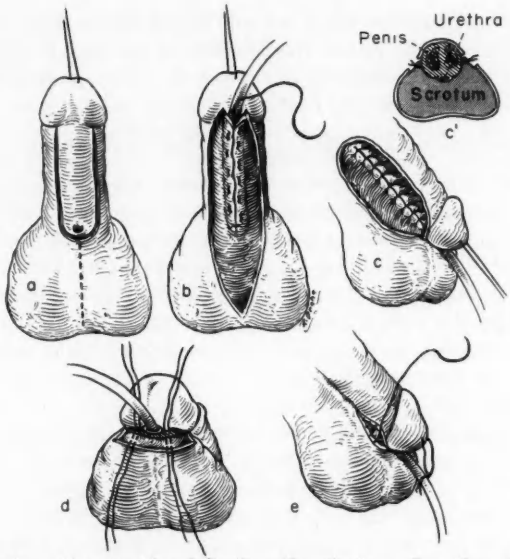

FIG. 3. First stage of conventional Cecil urethroplasty. *a*, Location of incisions. *b*, New urethra is constructed over indwelling catheter with continous Lembert suture of 4-0 chromic catgut. *c*, New urethra is buried in scrotum with interrupted fine catgut sutures which are attached high on lateral aspect of corpora, *c'*, *d*, Incised glans is attached to subcutaneous scrotal tissue. *e*, Final closure of penile and scrotal skin is made with continous subcuticular suture of fine catgut. Silk traction suture in glans helps anchor catheter.

urethra. New urethra of excessively large caliber is almost as undesirable as one that is too small.

Lateral dissection of the penile skin is kept close to the corpora. The medial strip should not be undermined. The skin is freed widely at the penoscrotal juncture to prevent indentations at this point during the final closure.

Size of the indwelling catheter varies from 10F to 18F depending on the age of the patient but is dictated by the contemplated caliber of the meatus rather than the diameter of the new urethra. This is determined accurately *before* any of the urethra is constructed. If there is any degree of tension when the tissues are approximated over the splint at the base of the glans, a smaller catheter is used.

Burying the urethra in the scrotum is expedited by starting distally. Incised glans is sutured to the dependent portion of exposed deep scrotal tissue (fig. 3, *d*). These sutures of 4–0 chromic catgut usually stop oozing from the glans. Similar sutures along the corpora are placed high enough to reinforce the new urethra over a broad area (fig. 3, *c'*). The scrotal bed is attached snugly to prevent pockets adjacent to the urethra.

In the final closure it is best to pass the continuous subcuticular suture through all layers of the scrotal skin and of the glans on each side of the meatus or reinforce this portion with interrupted sutures.

A gauze dressing is applied for only 24 to 48 hours. Use of Sitz baths and heat cradles will control local infection. Antibiotics are not administered routinely. The catheter is removed on the sixth or seventh day.

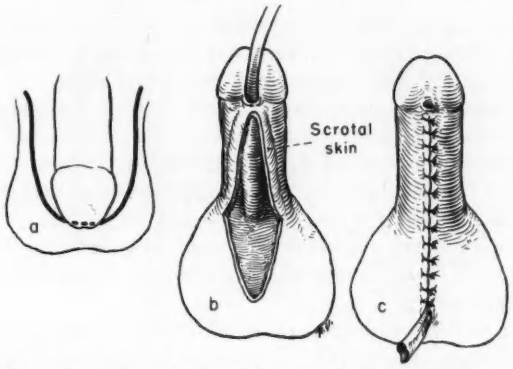

FIG. 4. Second stage of conventional Cecil urethroplasty. *a*, Incisions in scrotum are joined at the new meatus. *b*, With catheter in place for orientation, urethra is freed from scrotum. *c*, Skin is closed with interrupted silk sutures and rubber drain is left in dependent portion of scrotum.

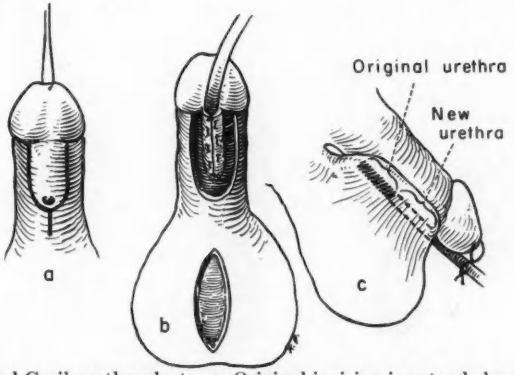

FIG. 5. Modified Cecil urethroplasty. *a*, Original incision is extended posteriorly so that portion of normal urethra can be exposed. *b*, New urethra is constructed over indwelling catheter and corresponding incision is made in scrotum. *c*, Penis is attached to scrotum in usual manner but segment of normal urethra is buried as well as newly constructed portion. Penoscrotal region is left free.

Second stage: At least 2 months should elapse before the penis and urethra are freed from the scrotum. Shorter intervals may suffice but have been known to be disastrous. The method employed is shown in figure 4.

Dissection should not be carried too close to the new urethra and yet thick masses of fibrous tissue should not be left on the ventral surface. The scrotal strips can be sacrificed entirely if sufficient penile skin remains for the final closure, but it is not advisable to free the penile skin extensively if a temporary fistula followed the first stage; the old fistulous tract may be opened.

A circular dressing is employed. The drain is removed after 24 to 48 hours. Skin sutures are taken out on the seventh day or when healing appears complete.

Modification: If the penile meatus is well removed from the penoscrotal juncture, only the distal portion of the penis is attached to the scrotum (fig. 5). New urethra is constructed as in the previously described procedure and is

buried in the same manner but it is essential also to include a generous portion of the adjacent intact urethra. The fact that the penoscrotal segment is unattached eliminates much of the dissection at the second stage.

2. Scrotal and perineal hypospadias (21 cases). Early in the period covered by this study a few patients with scrotal hypospadias were cured by the Cecil method by interposing a layer of deep scrotal tissue between the scrotal and penile segments of the new urethra. The integrity of this intervening barrier is unpredictable and the freeing of new urethra from new urethra can be extremely difficult. Eventually urethrourethral fistulas were encountered and the technique was abandoned. It is best to confine the Cecil operation to penoscrotal and penile varieties of the deformity.

In three cases an effort was made to convert scrotal or perineal hypospadias to the penoscrotal form at the time the chordee was corrected, so that they would be suitable for the Cecil operation. The Thiersch-Duplay principle was used as shown in figure 6, *a*, *b* and *c*. There was a tendency for the meatus to end up just back of the penoscrotal juncture. This was accepted as forewarning of impending difficulties and the plan was discontinued.

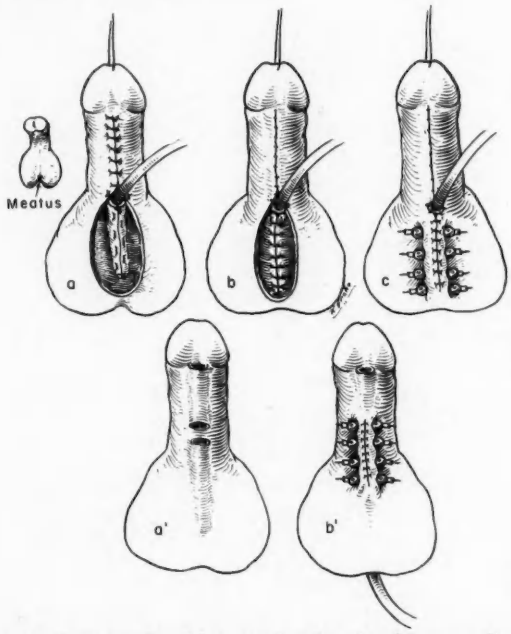

FIG. 6. Earlier methods employed in scrotal and perineal hypospadias. *a*, At same time chordee is corrected, new urethra is constructed to penoscrotal juncture over indwelling catheter by Thiersch-Duplay technique. *b*, Deep scrotal tissues are approximated over new urethra. *c*, Final closure includes double-stop sutures of nylon and interrupted fine catgut sutures in edges of skin. *a'*, Independent scrotal and pendulous segments of new urethra constructed by Thiersch-Duplay method and (*b'*) joined later by Denis Browne principle after diverting urine by perineal urethrostomy.

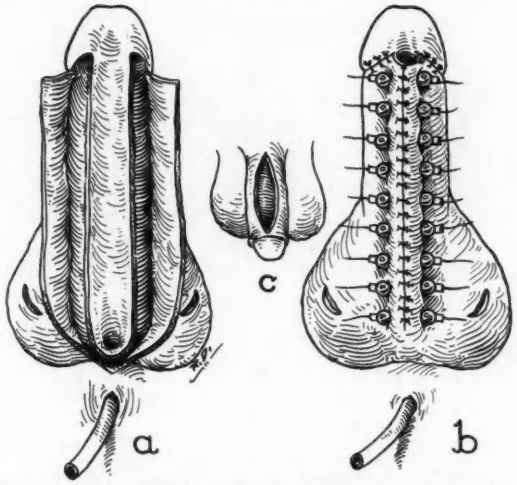

FIG. 7. Denis Browne urethroplasty. *a*, After diversion of urine by perineal urethrostomy, medial strip of skin is created, and lateral flaps of skin are freed extensively and incised at base of glans. Drainage tracts in scrotum are formed through stab wounds and a small area is denuded on each side of glans. *b*, Skin is attached to denuded glans with fine catgut sutures and remainder is approximated with double-stop sutures of nylon as well as interrupted sutures of fine catgut. *c*, Generous dorsal slit is made.

In two cases of perineal hypospadias without residual chordee, the scrotal urethra was constructed in the same manner but an independent pendulous segment was also formed by the Thiersch-Duplay method at the same operation (fig. 6, *a'* and *b'*). The intervening defect was treated as a fistula at a subsequent stage.

During recent years the Denis Browne operation has been used initially in all cases of scrotal and perineal hypospadias. An attempt has been made to follow the technique in every detail as Browne described and demonstrated it. The same types of sutures, beads and aluminum stops were employed. Urine was diverted by perineal urethrostomy; stab wounds were made in the scrotum and the generous dorsal slit was included routinely (fig. 7).

The Denis Browne operation is not mastered promptly or easily. Admittedly it was employed in only the most difficult cases in this series. Results were unpredictable except for the fact that the scrotal segment always healed. Since this is a distinct asset that permits completion of treatment by several methods, it continues to be the choice for scrotal and perineal hypospadias.

3. Fistulas only (21 cases). Just about every conceivable type of urethral defect was encountered in this group. Fistulas were cured by variations and combinations of the Cecil and Denis Browne procedures. In many instances more than one operation was necessary.

A slight modification of the Browne technique (fig. 8, *a*, *b* and *c*) was used for single small fistulas. A version of the Cecil method was employed for solitary larger defects. Only the midportion of the pendulous urethra was buried in most

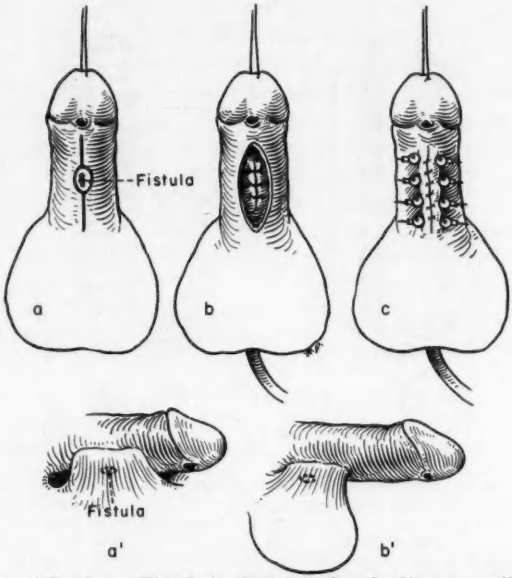

FIG. 8. Closure of fistula. *a*, Fistula is circumcised and adjacent penile skin is incised. *b*, After insertion of catheter perineally and excision of the fistulous tract, adjacent deep tissues are closed with interrupted fine catgut sutures and (*c*) skin is closed by Browne method. Larger fistulas are buried in scrotum. This may require attachment of only mid-portion of urethra (*a'*) or only proximal segment (*b'*).

TABLE 1. *How hypospadias was corrected in 105 cases*

	Total	Initial Operation				
		Cecil		Browne		Thiersch-Duplay
		Usual	Modified	Usual	Modified	
Total cases	105	57	21	18	4	5
No more treatment	65	37	14	10	4	
Additional surgical procedures						
Cecil	10	2		5		3
Browne	9	2	3	2		2
Duplay	5	4		1		
Secondary closure	6	4	2			
Meatotomy	6	4	1			1
Internal urethrostomy	3	1	1			1
Drainage of scrotum	3	3				

instances (fig. 8, *a'*). In a few cases the fistula was just beyond the penoscrotal juncture and only that segment was attached to the scrotum (fig. 8, *b'*). When the fistula was near the meatus, the entire terminal portion required revision and was buried, as shown in figure 5.

Multiple fistulas were converted to a single large one. Frequently they involved

TABLE 2. *Present status of 172 hypospadiacs treated in the period August 1950, to February 1957*

	Patients	
Meatotomy alone performed (mild without chordee)		14
Chordee alone corrected		41
Too young for urethroplasty	15	
Ready for urethroplasty	26	
After urethroplasty		117
Cured	105	
Urethra still buried in scrotum	4	
Persistent complications	8	

TABLE 3. *Complications after treatment of chordee and hypospadias*

	Total	Type of Operation					
		Correction of chordee	Cecil		Browne		Thiersch-Duplay
			Usual	Modified	Usual	Modified	
Total operations	253*	107	72	23	28	13	10
Fistula							
Temporary	14		10	1	3		
Persistent	27		4	3	12	3	5
Wound separation	8	2	4	2			
Retracted meatus	9		4	2	3		
Residual chordee	1	1					
Stricture							
Meatal	16	4	9	2			1
Deep	3		1	1			1
Excessive bleeding	4		4				
Keloid	1				1		
Total complications	83	7	36	11	19	3	7

* 91 second stages of Cecil operation not included.

practically all of the pendulous urethra. Some solitary ones were equally extensive. The conventional Cecil operation (fig. 3) was used in these situations.

Comment. All of these operations can be performed just as easily at the age of four or five years as at later ages. Twenty-six patients were cured before they started school. The others were in older age groups when first seen. Nevertheless, 60 per cent of the 105 who have completed all treatment did so before the age of 12 years.

Although 105 individuals need no further treatment, only 65 were cured by the author's initial efforts. Additional surgical procedures were necessary in the other 40 cases (table 1). By the time all of these 105 patients were cured, 88 conventional or modified Cecil operations had been performed, the Denis Browne principle had been used 31 times, the Thiersch-Duplay procedure had been employed 10 times, and 18 relatively minor operations had been necessary. Patients who had not been subjected to previous urethroplasties required an average of 2.2 operations for construction of a suitable, intact urethra.

MANAGEMENT AND PREVENTION OF POSTOPERATIVE COMPLICATIONS

The present status of the 172 patients included in this study is summarized in table 2. Postoperative complications of varying gravity were encountered (table 3). Increased experience has shown that many of these can be prevented by appropriate precautions.

Complications after operations for chordee. Residual chordee: Persistent angulation of the penis is the most serious aftermath of these procedures. Although 19 per cent of the previous attempts to correct chordee had been unsuccessful, only one of the 107 attempts of the present series failed. Residual chordee in this case was corrected at a second operation. When further straightening is necessary, it is best to allow 1 year to elapse between operations.

Stricture: Meatal strictures developed in four patients after Z-plasty. Dilatation sufficed in two cases but meatotomy was necessary in the other two. If special care is taken to preserve the original meatus (as illustrated in figure 2), meatal stenosis will be avoided despite considerable freeing of the urethra. If a meatal stricture should occur, it is wise to treat it adequately *before* resorting to urethroplasty.

Wound separation: Two patients had enough delay in wound healing to require secondary closures. There was no recurrence of chordee in either case.

It is apparent, therefore, that correction of chordee can be virtually devoid of complications if all constrictions are removed, if any meatus of adequate caliber is left intact and if the vascularity of the skin is not impoverished.

Complications following urethroplasty.—Complications after construction of the new urethra are the most disturbing and yet they are most amenable to prophylactic measures.

Fistula: Any complication is annoying, but fistulas have been the most disconcerting. Minute ones can be just as difficult to close as large defects. There is increasing evidence that fistulas can be prevented more easily than they can be repaired. They occurred after 19 per cent of the Cecil operations, 44 per cent of the Browne procedures and 50 per cent of the Thiersch-Duplay operations.

When performed properly the Cecil operation deliberately provides for a long tract so that it may heal spontaneously. This was true in 11 of the 18 fistulas. The seven that persisted were due to poor surgical judgment. The urethra was freed from the scrotum too soon in two patients who had had several previous operations. Portions of the urethra sloughed in each case and the operation had to be repeated. When there have been numerous earlier surgical procedures the urethra should remain buried for three months. In two other cases the operation failed because it was used for scrotal hypospadias and urethrourethral fistulas developed. Three fistulas after burial of only a portion of the urethra could have been avoided if sufficient normal urethra had been attached to the scrotum.

Three fistulas that followed the Denis Browne operation healed spontaneously but 15 persisted. Surgeons more experienced with this method admit an incidence of fistula of approximately 20 per cent. The operation was repeated with success in two cases and with failure in three others. The Cecil method has been used to construct the remainder of the urethra in five of these patients.

All defects after the Thiersch-Duplay operation were closed by the Cecil or modified Browne method.

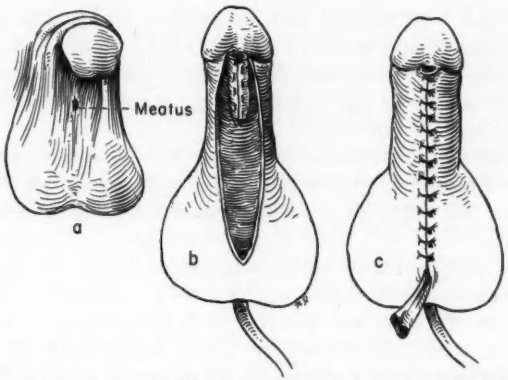

FIG. 9. Revision of new meatus. When meatus retracts into scrotum (*a*) following first stage of the Cecil operation, a new terminal segment is constructed by the Thiersch-Duplay method (*b*) at same time penis is freed from scrotum. Urine is diverted by perineal urethrostomy. Skin is closed and scrotum is drained in usual manner (*c*).

Wound separation: Obviously all fistulas were associated with some degree of wound separation but the term is reserved at this time for unique situations.

Six patients had so much separation of the tissues along one juncture between penis and scrotum a week after the Cecil operation that the indwelling catheter was exposed for considerable distance. Persistent fistulas undoubtedly would have developed. There was prompt healing in each case after simple secondary closure of the skin. No attempt was made to do anything about the urethra per se. The entire new urethra is now of good caliber in each of these cases. This suggests that burial of only a strip of skin probably would suffice.

Retraction of meatus: The new meatus retracted after six first-stage Cecil operations and three Denis Browne procedures (fig. 9, *a*). For practical purposes these can be considered fistulas involving the meatus. If the urinary stream cannot be directed properly, reconstruction of the meatus is imperative. This was done in five cases by the Thiersch-Duplay method as shown in figure 9, *b* and *c*. The method was successful in four instances and failed in one.

Catheters of proper caliber, more meticulous construction of the new meatus and use of reinforcing sutures when the skin and glans are approximated have prevented meatal retraction after the Cecil operation but it continues to be a problem following the Denis Browne procedure.

Stricture: There were 11 meatal strictures after 95 Cecil operations. Most of these were the result of efforts to avoid a gaping or retracted meatus. Five required meatotomy. A similar meatal stenosis followed the Thiersch-Dulpay procedure in one case and was corrected by meatotomy.

Three patients required internal urethrotomy. All three strictures were at the site of the original hypospadiac meatus and were treated with the Otis urethrotome. If adequate calibration and appropriate enlargement of the meatus had been provided *before* the first urethroplasty, urethrotomy probably would not have been necessary.

Hemorrhage: There was excessive bleeding from the glans after one urethro-

plasty because the new urethra was constructed to the tip. Such grandiose ambitions have been abandoned.

Three hematomas in the scrotum had to be evacuated but such hematomas have been prevented in all subsequent cases by insertion of the drain at the second stage of the Cecil operation.

Keloid: A generous dorsal slit is said to be an essential part of the original Denis Browne operation. This area usually heals promptly once the edema subsides. But in one case there was painful angulation during erection and the scar had to be excised.

Sacculated urethra: In three cases large, dilated pouches along the urethra were excised during one of the previously described procedures. All three resulted from the infamous Ombrédanne operation. This procedure is mentioned only to condemn it. Even if all hair follicles are destroyed it creates pouches that will not drain satisfactorily.

Unrelated anomalies: It has been axiomatic that other abnormalities should be suspected when one type of congenital anomaly is encountered. Fourteen undescended testes, two inguinal hernias and three hydroceles were operated on successfully at the same time that chordee was corrected or when the penis was freed from the scrotum.

Additional anomalies detected in this series of 172 patients included ureteropelvic obstruction, rectourethral fistula, testicular agenesia, cleft palate, absence of an ear, hammertoes, cardiac septal defects, the adrenogenital syndrome and true hermaphroditism.

Comment. Although the incidence of postoperative complications presumably can be reduced, it is unlikely that they can be eliminated. The seriousness of such sequelae and the ease with which they can be corrected at subsequent procedures help to define the usefulness of any technique.

Enthusiasm for the two-stage Cecil operation has been based on the following observations: 1) it alone promises to eliminate persistent fistulas, 2) total hospitalization for both stages frequently is less than that required by one-stage operations even when they are successful, 3) a desirable type of new meatus can be created with gratifying regularity, 4) any inadequacies after the first stage usually can be corrected during the second stage, and 5) it permits more precise forecast of the amount of treatment that should be necessary in any age group.

GENERAL OBSERVATIONS

Experiences with 172 hypospadiacs have emphasized that treatment of this anomaly demands infinite patience, meticulous attention to seemingly trivial details, adherence to sound surgical principles, flexibility to cope with the bizarre and the grotesque, and immunity to unwholesome rationalizations.

Many different basic problems may be encountered. Many types of operations are feasible and justified; none is foolproof. Hypospadias continues to be both a technical and a philosophic challenge, and it is unlikely that there is any legitimate role for the occasional operator in the proper management of these anomalies.

THE PROCESS OF URETERAL REPAIR: A RECAPITULATION OF THE SPLINTING QUESTION

DAVID M. DAVIS

A century ago the great French master of urology, Albarran, recommended that after operations on the kidney, the ureter be splinted with "as large a catheter as possible" for a prolonged period, at least several days. He had noted that where drainage of the kidney pelvis had been established, whether it be after removal of stones or after therapeutic drainage of a hydronephrosis or a pyonephrosis, pain disappeared, fever receded, and the patient usually underwent a rapid recovery. Yet when the surgeon, encouraged by this dramatic improvement, removed the drainage tube the condition only too frequently soon became just as bad as it had been originally. Albarran reasoned—please note this word, reasoned; he did not fall back on some previously established, obviously inadequate doctrine, but he reasoned that if the urine could leave the kidney as easily through the ureter as it had been doing through the drainage tube the patient would remain in a good state of health. This conclusion bears the mark of genius, and must be honored as such even though the method of treatment suggested, namely, splinting the intact ureter for several days with a large catheter, proved to be unsuccessful in most cases. Modern ureteral surgery has attempted, with a large measure of success, to improve on this treatment.

Sporadically individual surgeons began to try to enlarge narrowed areas in the ureter by applying the principles of plastic surgery as used in the skin. Others, particularly Guy Hunner in the United States, attempted to accomplish the widening by periodic mechanical dilatation to large sizes. Edward Keyes incised longitudinally a strictured and scar-surrounded ureter, placed in it for several days a large rubber tube, and obtained an unexpected and dramatic success.

Some surgeons splinted their plastic operations with tubes, others did not. In the procedure pioneered by Keyes, and later advocated by myself under the name of intubated ureterotomy, a splinting tube is essential to success. Darget and Ballenger[1] have recently, going back to Albarran's method, recommended enlarging strictures by forcing large catheters through them, and then leaving the catheter in place two weeks. Voices have been raised, sometimes judicially, sometimes rather emotionally, sometimes to attack and criticize splinting, sometimes to defend it. The resulting discord has been very confusing to all surgeons who wished to employ the best and most successful methods, and particularly to those beginning their work in ureteral surgery.

Fortunately this confusion is now beginning to clear away. As usually happens, the clearing is due to the accumulation of precise and detailed knowledge of how the organs and tissues concerned react under all the diverse conditions created by the surgical procedures under investigation. I shall try to summarize the significant researches, noting the various manners of approaching the problems,

[1] Minerva Clin. (Turin), **10:** 432, 1955.

and how the work of many investigators adds up to form a body of knowledge which will serve as the basis for building future advances in ureteral surgery much more intelligently than in the past.

The simplest experiments are those seeking satisfactory methods of repairing severed ureters. Straight end-to-end, oblique end-to-end, end-to-side, side-to-side, and telescoping end-to-end methods have been suggested, but the oblique end-to-end appears to be unquestionably the best. As to suturing, it would seem that delicacy and accuracy are the important matters, since some employ inverting mattress sutures, others everting mattress sutures, still others simple through and through sutures, all with success. Very fine catgut is the usual material, but Davalos[2] finds that the finest silk, precisely placed as in arterial suturing, is an excellent material. In this type of surgery first intention healing gives a paper-thin scar which can scarcely cause a stricture, and therefore splinting does not seem necessary. It is, however, interesting to see that Küss[3] in France and Merget[4] in Germany recommended splint catheters, while Davalos, in the United States, Hryntschak[5] in Austria and Zanaboni and his collaborators[6] in Italy, do without them.

In the field of ureterointestinal anastomoses, there is no solidifying of opinion. Coffey invariably used splinting catheters. Today it is probably that the majority uses splinting catheters when the ureter is anastomosed to the intact sigmoid or rectum, but dispenses with them if the anastomosis is to an isolated ileal loop or colonic segment.

The splinting-no splinting debate has raged most furiously about the plastic operations for the correction of ureteropelvic obstructions. Not only do different authors have different opinions, but individual authors change their minds from time to time, e.g. Thomas Gibson[7] of San Francisco. The operation of intubated ureterotomy, brought forcefully before the profession in 1943[8] has done more than anything else to stimulate experiments which have made comprehensible the behavior of the ureter when cut, sutured or splinted. If we add to this the knowledge derived from the work of those who have tried to bridge actual gaps in the continuity of the ureter, we are now able to predict with great accuracy what will happen in each case, and therefore to choose the best surgical method.

In 1948 I published, along with George H. Strong and Willard M. Drake, Jr.[9] the results of experiments on dogs in which a segment of ureteral wall about 2 cm. long and representing from ½ to ⅔ the circumference of the ureter was excised. The kidney was removed to eliminate urinary drainage from the field, and the ureter was allowed to heal about a splint of rubber tubing. The preparations showed that the defect in the ureter was quickly filled with a mass of inflammatory exudate, that the epithelial lining grew around the splint in five or six days, that the inflammatory exudate slowly contracted into what became

[2] J. Urol., **58:** 22, 1947.
[3] Mém. de l'Acad. de Chir., **80:** 769, 1954.
[4] Ztschr. f. Urol., **49:** 221, 1956.
[5] Ztschr. f. Urol. Chir. u. Gynäk., **42:** 268, 1936.
[6] Arch. Ital. di Urol., **27:** 150, 1954.
[7] J. Urol., **76:** 708, 1956.
[8] Surg. Gynec. & Obst., **76:** 513, 1943.
[9] J. Urol., **59:** 851, 1948.

eventually nothing more than a longitudinal linear scar in the ureteral wall, and that, as the inflammatory mass contracted, the muscular wall of the ureter followed it along until at the end of four to six weeks, normal appearing muscle occupied 90 per cent of the circumference of the ureteral wall. Observations in situ showed that this reconstructed and enlarged ureter underwent normal-looking peristalsis, and propelled the fluid contents of the ureter along in an efficient and apparently normal fashion. It was not shown whether the smooth muscle in the wall of the reconstructed part of the ureter was due to an actual proliferation of new fibres or whether it was simply the pre-existing muscle in the ureteral strip stretched out around the splint. At any rate, these conclusions, insofar as they went, have never been disputed, and have in fact been confirmed by all who have repeated the experiments.[10-15]

It was noted, clinically by us[16] and experimentally by Lapides and Caffrey,[11] that if the incised ureter remained in contact with any solid tissue such as the lower pole of the kidney, the peritoneum, or the psoas, quadratus lumborum, or other muscles of the back it became adherent to these structures and suffered distortion of its shape and interference with its proper motility. This could be prevented by surrounding the ureter and any exposed part of the pelvis carefully with fat. The reconstructed ureter then floats surrounded on all sides by the perirenal fat and can adapt itself readily to the up and down movements of the kidney without kinking or tension.

The question as to whether there was actually regeneration of smooth muscle fibres in the reconstructed ureter or not aroused much interest. The most decisive answer was given by Hinman and Oppenheimer[14] who fitted their splint tube with a fine wire mesh through which the ureteral elements had to grow in order to surround the splint. The resulting preparations showed that both epithelium and smooth muscle put forth new cells which grew through the fine interstices of the wire mesh. Most fascinating is the behavior of the smooth muscle fibers after passing the mesh barrier. Upon its far side they find a mass of inflammatory exudate springing from the adjacent fat. The epithelial cells proliferate rapidly, covering the surface of the inflammatory mass where it is in contact with the foreign body, that is, the splint. The smooth muscle cells multiply more slowly, but unerringly make their way around the circumference of the ureter, maintaining their proper distance from the epithelium which has preceded them, and never diverging or spreading out peripherally into the inflammatory mass except just enough to create a layer of smooth muscle of the exactly right thickness to provide the necessary peristaltic activity for the reconstructed ureter. To my mind, this is a phenomenon just as impressive as the regeneration of a complete leg by a lizard after amputation, and of the same general nature. In a tissue culture all body cells show unlimited power of proliferation in all directions; in the body their growth is limited and controlled so that they form themselves

[10] J. Urol., **72:** 350, 1954.
[11] J. Urol., **73:** 47, 1955.
[12] J. Urol., **73:** 53, 1955.
[13] J. Urol., **71:** 274, 1954.
[14] J. Urol., **75:** 428, 1956.
[15] J. Urol., **74:** 476, 1955.
[16] J. Urol., **66:** 77, 1951.

into functioning organs as though according to some divinely made blue-print. The mode of action of these controlling forces is still as mysterious as ever, and today all we can do is to study them and learn as much as possible about the results of their activity.

The primary reason for the insertion of a splinting tube has been from the beginning to provide a mold around which the healing process could take place and which would insure that the ureter would, after healing was complete, have a fully adequate caliber. Intubated ureterotomy has proved that it is possible in this way to insure that the reconstructed segment of ureter will actually have a caliber much larger than that of the original segment.

Inquiring minds always wish to go a step farther, and Frank Hamm of Brooklyn has such a mind. He questioned the desirability or the necessity of placing a foreign body splint after incising the ureter. A few references to earlier history will be interesting at this point. When an epidermoid carcinoma invades beneath the surface, proliferation of its cells produces cyst-like cavities lined by malignant epithelial cells and filled with desquamated epithelial cells. Pieces of skin experimentally placed beneath the surface form epithelium-lined cysts. I personally observed 35 years ago that if a defect in the perineal urethra was bridged by a large catheter left in until healing was complete, an epithelium lined tube would be produced which would function perfectly adequately for the passage of urine. Of course in this region the tube has no muscle in its walls. Bengt Johansen[17] buried a rectangular flap or strip of perineal skin to fill such a gap in the urethra, and found that it would form itself into a tube even if no splinting catheter were present. Denis Browne[18] using the same principle for the surgical treatment of hypospadias, reports excellent results. Stimulated by this work, Reed Nesbit[19] performed experiments in animals which showed that the tube formed in this manner would not have a circumference equal to twice the width of the buried strip, but that the strip ought to have a width about equal to the circumference desired for the new urethral tube—not its diameter. This observation may be very pertinent in considering the methods for enlarging the caliber of the ureter.

That the ureter will heal very well after a longitudinal incision, with or without sutures, is well known to every surgeon who has performed ureterotomy for stone. Unless there are severe complicating factors no stricture results. In 1927 Kairis and Perlman[20] performed experiments very like those of Hamm and his collaborators. They removed oval pieces of ureteral wall, and noted that the ureter quickly re-established itself, without splints. It would seem, however, that there would be little chance of the ureter actually enlarging its caliber as a result of longitudinal incision unless a splint of a caliber larger than that of the original ureter was present. Nevertheless Hamm and his collaborators[21-24] operated on both dogs and humans in this manner, and obtained good results in

[17] Acta Chir. Scand., Supp., 176, 1953.
[18] Post-Grad. Med. J., **25:** 367, 1949.
[19] J. Urol., **64:** 389, 1950.
[20] Ztschr. f. Urol., **21:** 659, 1927.
[21] Proc. N. Cent. Sec. Am. Urol. Assoc., p. 52, 1954.
[22] Tr. Am. Assoc. Gen-Urin. Surg., **46:** 109, 1954.
[23] J. Urol., **73:** 475, 1955.
[24] J. Urol., **75:** 43, 1956.

spite of the absence of splints. Of 11 operations on dogs in which a segment of ureteral wall was removed, four developed strictures, while seven had good results, the lumen of the ureter being described as "adequate", although the authors state frankly that the lumen of the healed ureter was smaller than that of the original ureter. Nine human cases of hydronephrosis treated by ureterotomy without splinting gave good clinical results. Pre and postoperative pyelograms of 4 cases are published, and the hydronephroses are smaller in spite of the fact that the treated parts of the ureter look quite narrow.

The work of Hamm has raised fascinating questions about the ureter, and has done more to stimulate investigators to try to answer them than anything that has happened in a long time. Are splints necessary? If used are they harmful? If their effects are both beneficial and harmful, do the beneficial effects outweigh the harmful ones sufficiently to justify their use? Cordonnier and Roane[25] studied the effects of catheters kept in intact ureters for a long time, and found chronic inflammatory manifestations as well as muscular hypertrophy. However, these changes disappeared in 4–5 weeks after removal of the catheters. In our early work with intubated ureterotomy we noted that if a splint tube was placed so that its lower end lay within the ureter, it might produce a stricture at this point. For this reason we began to extend the splint through the entire ureter which did away with this undesirable effect. A number of authors have regarded splints as very likely to encourage and propagate infection. In my opinion this claim has not been substantiated. Infection is favored only if drainage of urine from the kidney or of secretions from the remainder of the wound tract is inadequate. With modern antibiotic drugs and correct surgery infection should not contraindicate the use of splints. Splinting tubes in contact with urine may become coated or occluded by deposits of calcareous material. This complication, which may be very serious, has been combated by three means, first, frequent, or even constant irrigation with acid solutions; second, general measures against stone formation, especially high fluid intake, acid-ash diet, acidifying drugs, and specifically active substances such as acetylsalicylic acid and salicylamide; and third, the use of nonwettable materials for splints, especially polyethylene plastic. Polyethylene tubes of suitable diameter are inconveniently rigid, so that some have tried other plastics such as polyvinyl. Unfortunately some individuals are allergic to polyvinyl in such a way that an extensive scar-tissue reaction is caused. I have reported a case in which both ureters were completely obliterated following intubation with polyvinyl tubes.[26]

The above summary shows that there are definite hazards associated with the use of splinting tubes, and it would appear that while most of these hazards can be successfully met with skill and with careful, patient postoperative management, splints should be avoided unless it can be shown that they are really necessary for successful results. This of course means that we must know precisely when splints are necessary and when the omission of splinting will not compromise the success of the operation.

[25] Surg. Clin. North Amer., **30:** 1523, 1950.
[26] J. Urol., **74:** 747, 1955.

Much light has been cast into this dark but important region by the clever and thorough experiments of Hinman and Oppenheimer.[14, 15, 27, 28] They state the problem as follows: "The presence of ureteral splint provides a guide for healing. The normal sequences involved have been studied but little is known of the aberrations from the norm. The current urologic trend is away from splints and tubes, but the physiopathologic reasons for and against such devices have not been made clear."

They made longitudinal incisions in the ureters in the fashion usual in such experiments. Some they left alone, without sutures or splints, and in others, omitting splints, they tacked the remaining ribbons of ureter flat against in some cases fat, in others peritoneum and in still others muscle. Some have suggested that urine flowing through a healing ureter has a beneficial effect, first by keeping the lumen distended and thereby increasing its caliber, and second by stimulating the peristaltic action of the ureteral muscles and thereby strengthening them. Hinman and Oppenheimer, in order to test this thesis, allowed the urine to flow down the ureter freely in some cases, providing a rubber tissue drain to carry it off, and in other cases excluded urine from the operative field altogether by ligating the ureter tightly above the ureterotomy.

The results of these experiments are clear-cut. I can express them best by quoting the authors. "A simple incision heals rapidly and with little fibrosis." Intubation was not necessary if portions of the ureter were not resected. Healing was not perfect even after 14 weeks. Of significance is the finding that even the simplest incision without any urinary flow or leakage heals with appreciable scarring. Urinary flow does not greatly change the pattern of regeneration, but the process takes longer.

"The process of healing after a larger defect which is fixed open and unsplinted has (hitherto) only been speculated upon. . . . If the ureteral edges are allowed to lie open and free our experimental data indicate that, although healing occurs without significant obstruction in most animals, the ureteral wall is not properly reconstituted. If the edges of the ureter are forced to lie free in the retroperitoneal space, and not guided to reapproximate themselves by either splint or suture profuse epithelial overgrowth occurs resulting in sacculations, double lumens and walls composed only of fibrous tissue and bone.

"Urinary flow, if adequately drained so that pooling does not occur at the site of repair, does not inhibit repair as much as would be expected. However, those defects from which the urine is diverted heal somewhat better than those through which urine flows."

Further experiments with spread out ureterotomies show that healing is least distorted when the ureteral ribbon is completely surrounded by fat. Distortion is greater if the ribbon is fastened to peritoneum or muscle, and the ureter becomes adherent and is thereby more or less restricted in its movements.

These authors are actively continuing their work on the ureter, and no doubt others are similarly occupied so that we may expect further clarification of details.

[27] J. Urol., **76:** 729, 1956.
[28] Surg. Gynec. & Obst., **103:** 416, 1956.

In considering the limitations on the usefulness of splints one other important point must be considered. It will be remembered that in studying ureteroureteral anastomosis all investigators found that the best results were obtained when a very precise technique brought about an approximation so accurate that scar was reduced to a minimum. However, since there may be in some cases so much actual loss of ureteral substance that approximation of the two ends is impossible, a method of bridging such a gap was eagerly sought. As long ago as 1934 Wiseman[29] tried splinting the gap with a catheter left in for 10 to 14 days. He found that the splint was quickly surrounded by epithelium, but that outside the epithelium there was nothing but scar tissue, so that the end result was stricture in every case.

The remarkable success of intubated ureterotomy suggested that the ureter would reconstruct itself over a splint longitudinally just as well as circumferentially, so that, undeterred by Wiseman's findings, many others have tried to bridge the ureteral gap. Sutherland and his co-workers[30] used a polyethylene splint without sutures excising one inch of ureter in some experiments, merely transecting the ureter in others. If the splint was removed before the eleventh day complete occlusion followed; from the eleventh to the twenty-third day, severe strictures were the rule; after the twenty-third day, stricturing was described as "minimal." Stricture of some degree obviously occurred in all cases, and the report gives no evidence of any longitudinal smooth muscle regeneration. Huffman, McCorkle and Persky[31] carried out similar experiments, except that a segment of ureter was removed in each. Careful microscopic preparations showed that the channel occupied by the splint became lined with epithelium, but that smooth muscle never proliferated lengthwise of the ureter. The scar tissue outside the epithelium always contracted after the removal of the splint, so that no success was attained. Hinman and Oppenheimer,[14] in the course of other experiments noted that sometimes the strip of ureteral wall which was supposed to remain in contact with the splint fell away from it. When this happened, the ureteral strip reformed with reduced lumen and complete muscular coat just as in the splintless experiments of Hamm and Weinberg. Epithelium grew about the splint forming a complete second lumen, but there was never any proliferation of smooth muscle lengthwise along the splint (fig. 1).

One might say in passing that other attempted methods of bridging the gap have failed. Hardin[32] substituted polyethylene tubing, segments of veins, and of arteries, all without success. Scher and his co-workers[33] and Chauvin, Payan and Jean[34] used polyethylene tubing. Scher claims a degree of success in some of his animals, but the period of observation is not long. Chauvin found that strictures usually formed at both ends of the polyethylene prosthesis, and that even if the prosthesis was removed after a long time, there was no muscle in the wall of the channel, and strictural contraction was the rule. Results were no

[29] Brit. J. Urol., **6:** 11, 1934.
[30] South. Med. J., **47:** 525, 1954.
[31] J. Urol., **75:** 796, 1955.
[32] A. M. A. Arch. Surg., **68:** 57, 1954.
[33] J. Urol., **73:** 987, 1955.
[34] J. d'urol., **60:** 871, 1954.

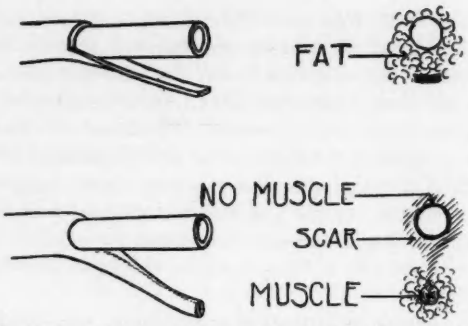

FIG. 1. Formation of double lumen when ureteral strip falls away from splint tube. No muscle about splint.

better if the polyethylene tubing was invested with a segment of vein. Schein, Sanders and Hurwitt[35] bridge the gap with an autograft of a segment of fallopian tube, but found this structure unable to conduct enough urine to be of any value.

If one digests the results of all this work the strange facts of ureteral regeneration take tangible form, and can be used in planning surgical attack on any kind of ureteral lesion. They may be expressed simply as follows:

1) If the ureter is incised longitudinally, it will reconstitute itself completely, with epithelial lining and muscular coat, with or without a splint.

2) If the ureter is divided transversely, the epithelium will regenerate along a splint or across a suture line, but the muscular coat will never regenerate lengthwise of the ureter, whether the gap be wide or narrow.

The reasons for this extremely selective behavior of the ureteral muscle are still entirely unknown, and offer a fascinating field for future research.

I believe at this time it is possible to make the following additional statements:

a) If the ureter is of normal size or greater before longitudinal incision it will heal without a splint and of the same caliber as originally.

b) If the ureter is smaller than normal before longitudinal incision, or if for any reason it is desired to increase its caliber, it is necessary to insert a splint of the size desired for the lumen after healing. A complete functioning ureter of increased size with epithelial lining and functioning muscular coat will be obtained.

c) If an actual gap in the continuity of the ureter must be bridged, no success can be anticipated from splints or any form of prosthesis yet suggested, and recourse must be had to ileal loop substitution or some form of plastic operation, such as the formation of a tube from a flap of bladder wall.

d) If conditions permit the ureteral narrowing to be corrected by a plastic operation, as at the ureteropelvic junction, a splint tube is unnecessary if primary healing occurs. If there is doubt of this, as for example if the operative field is already seriously infected, a suitable splint tube is advantageous in that it offers a good chance of retrieving a good result even if the sutures of the plastic operation pull out as a result of the infection.

[35] A. M. A. Arch. Surg., **73**: 47, 1956.

e) In any kind of an operation on the ureter, the result will be better if the ureter is completely surrounded with fat at the end of the operation.

f) If splint tubes are used it is better to use rubber or polyethylene tubes, avoiding all other kinds unless and until they are proved non-reactive and non-allergenic for all individuals.

g) Splint and drainage tubes must be cared for meticulously so long as they are in place to avoid first, displacement; second, occlusion from any cause, such as kinking, pressure, ligation, clamping or stoppage with blood clot or mucus; and third, sanding. Uroconcentration is avoided by copious hydration of the patient, and infection averted by skillful use of antibiotic drugs and adequate drainage of all infection or potentially infected regions.

h) If on consideration of all the presently known facts it is correctly concluded that no splint is necessary, postoperative care is simplified and the period of convalescence shortened. If on the other hand it is decided that a splint is necessary, postoperative care must be meticulous and the splint must be kept in place long enough to accomplish its purpose, usually 4 to 6 weeks.

I believe we can conclude that the splinting-no splinting debate will end as so many others have ended, that is, with the realization that there was right on both sides. Ureteral splinting is a tremendously valuable procedure because it will solve some surgical problems which cannot be solved in any other way, but the use of splints involves enough disadvantages so that they should not be used when they are not necessary.

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UROLOGY—AS OTHERS SEE IT

GEORGE C. PRATHER

All of you, accomplished veterans in the field of urology, have mature concepts in regard to the scope of, techniques in, and training for proficiency in this specialty. No doubt most of your opinions are valid because of your close attention to and thoughts about these problems over a period of many years. However, before final conclusions are reached on these matters, it might be wise to know what those in a larger field of medicine think about our specialty, urology.

I happen to have some information on this point in the form of answers to inquiries by a distinguished general surgeon, who acted as chairman of a committee to determine whether the urological service in a large general hospital should be continued or abandoned.

Just by chance at a dinner one evening my friend, the general surgeon and committee chairman, asked me if I would be interested in seeing the replies of 22 outstanding surgeons and professors of surgery concerning this problem. Feigning mild interest at that moment, I lost no time in obtaining the bound volume of letters the very next day for a careful digest of the opinions expressed.

Thus you have the background and basis for Urology—As Others See It. Permission has been granted by my surgical friend to use quoted statements, but of course the names of those responsible for the various opinions will be omitted.

Has urology become a firmly established specialty? Are urological departments or services in a large hospital justified? If so, what factors have been responsible and what factors will determine the future of urology as a specialty?

Sixty per cent of the outstanding general surgeons who replied to these points were convinced that urology was justifiably established as a specialty and would continue to be so. This point of view was expressed positively by "In brief I think that general surgery should not absorb urology and that the specialty will continue to be an important one if it is given a good deal of freedom.", and "For a long time to come I believe the major part of G. U. surgery will be done here by G. U. men.", or "I do not think we can abolish specialization since it is so firmly established and I think it has in general, justified its existence."

Twenty per cent were less affirmative in their opinion of urology as a specialty. To quote "I think that the specialty of urology as a whole has insulated itself to a point where the broad influences of medicine and surgery no longer make contact.", or "The time will not be too distant when we shall have to consider whether urology will not suffer the same fate that laryngology has suffered.", or "In short, I favor preserving the identity of urology as a specialty but am by no means sure that I am right."

Twenty per cent were definitely negative in their opinion that urology should be a specialty. A few sample statements are "I actually hope that you will make it a part of general surgery, because I actually believe such an arrangement would be advantageous to the patient as well as physician.", or "I feel that the more we can get the subspecialties of surgery back into the field of general

surgery, the better off everyone will be.", or "It seems to me a very good case can be made for reuniting urology and general surgery if a practical basis for doing so can be found."

From the quoted views expressed and tabulated it is evident that the majority of the general surgeons who replied have respect for and believe in urology as a surgical specialty, although a number regard our outlook as too narrow for the welfare of all. The majority favor a urological service in hospitals for the care of urological patients.

If one attempts to determine what has been responsible for the development of our specialty let me quote what our surgical friends have to say. "Doctor X and his associates over the past years have had a continuing program of research that certainly would not have been carried out had they not had their special interest in that field.", or "The urologist commands a diagnostic and therapeutic tool—the cystoscope—which is not available to others. He thus is in the enviable position of controlling both medical and surgical phases of his specialty.", "Medicine, surgery and now urology are proving grounds for basic physiological concepts.", or "In the field of investigation it is true that urology overlaps medicine, physiology, pathology and general surgery but I rather think that several groups approaching our common problems from different viewpoints may accomplish more than if they all work together."

I believe it is evident that two factors have been important in establishing urology on firm ground. Research, both basic and clinical, has produced great respect for urology in the minds of those who are well informed about problems relating to the urinary tract. If a specialty does not reveal new facts about the diseases or conditions in its field and thus contribute to the knowledge of medicine in general, it is derelict in its responsibilities.

The second important factor in the development of urology as a specialty is of course the special instruments which are available for both diagnosis and treatment. Skill in their use, by training and experience, commands respect from those not intimately familiar with these facilities.

An important question in many hospitals today is the relation of the urological department or service to that of the general surgical service. How do our friends in general surgery feel about this?

As one might expect, there is rather uniform opinion in the replies that I have studied. All feel that urology should be autonomous in the care of urological patients, but that from an organizational standpoint, the general surgical division should correlate all the surgical specialties and really be the boss. Let me quote some opinions—"The urological department should be an integral part of the division of surgery and participate in the surgical program.", "In its organization, urology should be a section of general surgery, both from the standpoint of hospital administration and of the university. Some narrow-minded urologist may feel that this arrangement detracts from the prestige of his specialty. Actually it insures a proper co-ordination with the total surgical program, guarantees best that the needs of an advanced training, teaching and an investigative program will be fulfilled, and that extreme specialization and compartmentation

will be prevented.", or "I believe all surgical subspecialties should be under the control of general surgery. We must recognize that some specialty fields, of which I believe urology is one, have special problems which can never be understood without a thorough general surgical background.", or "The urologic service should have a chief who directs the activities of the service, and the service should be intimately associated with the general surgical program. The urologic chief should be responsible to and serve under the jurisdiction of the chairman of the department of general surgery.", and as one man wisely said "So, with most discussions of this type, it is very difficult to plot a course or organizational decisions. If you get the right individual it will go well no matter what the administrative set up is and the wrong person will fail in any case. The more I think of such problems, the more convinced I am that the solution is the person."

As I have read the letters of these very distinguished surgeons, I have become convinced that their opinions were based on high motives and regard for the welfare of their hospitals and medical schools rather than as an expression of jealous or selfish interests. In fact there were only three out of 22 who appeared vindictive or antagonistic in their attitude toward urology. One might conclude therefore, that any system of organization relative to urology and general surgery could function well, provided both the urologist and general surgeon were capable and understanding and that neither was obstinate or of a dictatorial disposition.

We come now to the opinions of our surgical friends as they pertain to the training of men who will follow us in the urological field. Should the training be the same for all those who wish to be urologists? One opinion can be found in the following quote, "We have two types of people to train in this country: those who teach and do research; and those who practice." This opinion does not infer that the training of either type should be inadequate, but it does emphasize a concept that perhaps more than one specific or rigid training program might be desirable, depending on the ultimate goal of the prospective urologist.

Most of our present discussion will be devoted to the over-all training program. As one well-known professor of surgery expressed himself "I think that if one surveyed the field of urology over the country one could criticize a great many urologists because of the narrowness of their outlook; that is, many of them are interested in techniques. The way to correct this situation is to urge them to broaden the base of training and insist upon a training in the whole field of surgery as a preliminary to the special training in urology." Similar points of view are expressed by "The urologist should have an adequate training in general surgery before he becomes a surgical specialist." and by "If the properly and basically trained surgeons are to be attracted into this specialty and if the continuing and revivifying inflow of basic medical and surgical knowledge is to be assured, it is necessary to maintain a training program closely related to that of the parent discipline, general surgery. This objective can be realized if each surgical internship and assistant residency program contains a proper experience in urological wards and clinics. In our opinion, this is not less than one month at the internship level, and three months in a two or three year assistant residency. The urological resident should be chosen from the latter

group in which case two qualifying years of urology residency would be mandatory, or preferably after a year of general surgical senior residency in which case one year of urology should suffice.", or "This program should be two years for residents who have already had three years of general surgical training." or "Future urologists should have the benefit of from two to three years training in general surgery plus, perhaps, two years of sub-specialty training in urology.", or "I think that urology is very definitely a specialty but I do think that those who enter it should have a good training in the general field of surgery before they limit their activities to the genito-urinary tract." and finally "It is predicted that at least some of the outstanding urologists will oppose the program of which they themselves are a product."

A summary of the opinions of our outstanding surgical colleagues is to the effect that the best training for urologists should include considerable experience in general surgery prior to a two-year period devoted exclusively to urological techniques. A similar line of reasoning would no doubt apply to any of the surgical specialties.

In the letters upon which this paper is based we have, I believe, specific comment about our specialty which should be taken seriously. I have high regard for the individuals quoted and know from the nature of their letters to one of their surgical friends that they were expressing their real thoughts about the inquiry at hand.

There is no doubt that urology has developed into a well defined specialty. It is probable that this development and maturity has been brought about by 1) the skilled use of special instruments and operative techniques, 2) close attention to both the medical and surgical conditions or diseases of organs in our realm, 3) detailed estimate of the patient prior to any surgical procedure and 4) significant research, both basic and clinical, in our own and other departments of medicine and surgery. If these features have been responsible for the development of urology, let us continue to pursue the same principles to safeguard the future.

Concerning the organizational set-up in hospitals and medical schools, it appears advisable for urology to have adequate autonomy in the care of patients and provision for research, but that this can be accomplished as a subdivision of general surgery, provided the individuals involved have mutually high principles, are personally compatible, and have confidence in each other.

In regard to training, it is evident that the surgical intern and assistant resident should have transient experience in urology as part of their training in general surgery. Knowledge of the common urological disabilities in men and women, and of the urological modalities for diagnosis and treatment appear necessary for anyone with a modern background in medicine and surgery.

It may be important too, for those who wish to become urologists, not to limit themselves to urological training until they have had considerable experience in the wider field of general surgery. This would not necessarily prolong the total period of training if some flexibility were permitted between the years spent in general surgery and urology during the residency program. Our friends in general surgery, perhaps surprisingly to us, seem to agree that a two-year period of

intensive effort in urology would provide a qualifying experience. No doubt many of the outstanding urologists of today had training of this type. If one is to avoid the criticism of narrowness in point of view leveled at urology, we might well consider a broader background in surgery and a somewhat shorter period of training in the specialty itself. We who are intensely interested in our own specialty can often find wise counsel from those outside our own field. Let us give some thought to urology—as others see it.

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CYSTS OF THE PROSTATIC UTRICLE (MÜLLERIAN DUCT CYSTS): REPORT OF TWO CASES IN CHILDREN, EACH CONTAINING CALCULI, CURED BY RETROPUBIC OPERATION

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An increasing number of papers in the literature, relating to disorders of the remnants of the müllerian duct system in males, attests to the clinical importance of this subject. The subject has been well reviewed by Moore and Howe in 1953, and by Slocum in 1954, who give an extensive bibliography. The latter author states that 49 cases of müllerian duct cysts have been reported. Undoubtedly the incidence of such cysts, however, is more common than the literature would indicate, as borne out by the fact that we have seen personally several presented at informal pyelogram conferences at urologic seminars and sectional meetings.

The purpose of this paper is to present two cases of cyst of the utricle occurring in children, each containing calculi, and to describe a comparatively simple surgical technique for correction of the lesion when the cyst is not unduly large.

EMBRYOLOGY

It is generally accepted that the müllerian duct system which arises during the undifferentiated stages of development of the human embryo, gives rise to the fallopian tubes, uterus, and upper vagina in the female; whereas, in the male the müllerian ducts regress except for the cranial ends which persist as the appendices testes and the joined caudal ends which persist as the prostatic utricle or uterus masculinus (fig. 1). This is the depression which is noted in the midline on the verumontanum between the openings of the ejaculatory ducts customarily seen on routine panendoscopy. Failure of the normal regression may give rise to a cystic structure of varying size. Slocum lists persistence of müllerian duct structures on a genetic or hormonal basis and abscess formation in the prostatic utricle as possible etiologic possibilities in the formation of these cysts.

CLINICAL PICTURE

Symptoms vary tremendously depending upon the size of the cyst and the presence or absence of infection. In some reports no symptoms have been noted, a midline cystic mass in the region of the prostate being detected only on rectal examination. More commonly, however, disturbances of micturition, perineal discomfort, and bloody or watery urethral discharge have been reported. A very large cyst may be felt on abdominal palpation, and is usually considered to be a full bladder until its persistence after catheterization is noted. The most helpful diagnostic measure is radiographic demonstration of the cyst after injection of radiopaque dye by means of catheterization of the utricle or by perineal puncture. The cyst contents have been variously described as serous, mucoid, purulent, or

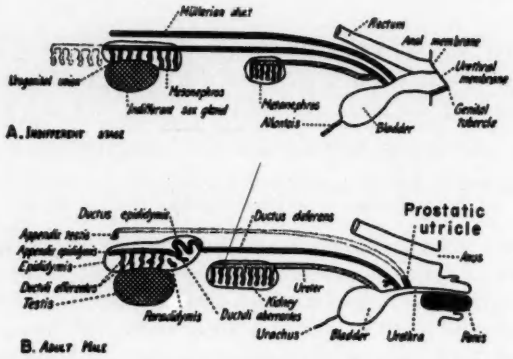

FIG. 1. Diagram showing male and female genital duct systems as present in undifferentiated stage and in fully developed male. (From Dodds, G. S.: Essentials of Human Embryology, 3d ed. New York: J. Wiley & Sons, 1946.)

hemorrhagic. Demonstration of subvesical location of calculi on oblique and lateral cystograms is suggestive evidence of a müllerian duct cyst.

TREATMENT

Depending upon the circumstances, rectal massage, conservative drainage by catheterization of the utricle, or perineal, suprapubic, or retropubic surgical excision has been carried out in the cases reported in the literature. In general the smaller cysts have been approached by the perineum while the larger ones, which have presented abdominally, have been approached from above. Due to the intimate association of the cyst wall with the undersurface of the bladder, prostate and rectum, the majority of the surgically treated patients have presented difficult technical problems.

The technique carried out in our two cases, namely, saucerization of the cyst through the retropubic transvesical approach would seem preferable where the size of the cyst would permit this. The details of the operation are described in the first case report below and are illustrated in figures 3 and 4.

CASE REPORTS

Case 1. D. M. & S. Clinic No. C 7591. An 18-month-old white male infant was seen on April 17, 1952 with a history of frequency, dysuria, bloody urine of 24 hours duration. Physical examination was normal. A plain x-ray film and a cystogram were normal. Cystoscopy with the No. 14 McCarthy miniature cystoscope, carried out under general anesthesia, disclosed diffuse acute hemorrhagic cystitis. The bladder neck was considered normal. Bilateral retrograde pyelograms showed mild right and moderate left hydronephrosis, both due to slight ureteropelvic junction obstruction. The symptoms and the urine cleared rapidly on chemotherapy so that it was felt proper simply to observe the child inasmuch as the upper urinary tract changes were not sufficiently marked to warrant pyeloplasty. A similar minor attack occurred a few months later but cystoscopy and pyelograms showed no significant change and it was again decided to observe the child.

No further symptoms occurred until April 25, 1955 at which time the boy was 4½ years of age. The child had been well over the preceding three years until a few days before the current admission when he had experienced considerable difficulty voiding, associated with low abdominal pain.

An x-ray (fig. 2, *A*) now showed a cluster of 14 small stones behind the symphysis, and the cystogram showed these calcific shadows to be subvesical in location (fig. 2, *B* and *C*). Excretory urography demonstrated slight hydronephrosis on both sides attributable to coincidental ureteropelvic junction obstruction. From the position of the stones it was surmised that they might well lie within a cyst of the utricle. Cystoscopy under general anesthesia now showed a definite contracture of the bladder neck with elevation of the floor, but no stones were seen within the bladder or prostatic urethra. There was questionable crepitation to the rectal examining finger.

Open operation was carried out on April 25, 1955 (figs. 3 and 4). Through a transverse suprapubic incision, the anterior surface of the bladder and prostatic urethra were exposed by the retropubic approach. The bladder was opened and found to be thickened and trabeculated. There was a definite rim of tissue at the bladder neck. No stones lay within the bladder. The incision was then extended longitudinally through the roof of the prostatic urethra. With the finger of an assistant in the rectum, the obstructing tissue at the posterior lip of the bladder neck was excised after the method of Burns. Palpation then revealed the calculi lying in a cavity about 1 cm. in diameter beneath the prostatic urethra and trigone. This cavity was opened and 14 stones measuring from 1 to 2 mm. in diameter extracted. The cavity was completely saucerized by excising its roof and suturing its lining mucous membrane to the mucous membrane of the trigone. The verumontanum could not be identified. The opening in the bladder and anterior prostatic urethra was closed, leaving a No. 14 Foley catheter indwelling. Exposure was excellent throughout the procedure. The remainder of the wound was closed in layers with Penrose drainage.

On analysis the stones were found to be composed of apatite (calcium phosphate). Histologic examination of the cyst lining showed "squamous metaplasia."

Convalescence was uneventful, the catheter being removed on the seventh day. Following this the patient voided with a strong forceful stream and with excellent control. The mother stated that in retrospect it had never been forceful preoperatively. Two months after operation, a checkup cystoscopy was carried out. The bladder neck was funnel-shaped, and the original remnant of the cyst had shrunken and become incorporated in the bladder neck.

Six months later the child was seen because of an acute attack of pain in the right renal area. Excretory urography showed progression of the right hydronephrosis, so ureteropyeloplasty on the right was carried out on November 15, and on April 6, 1956 a similar procedure was done on the left. Convalescence from both operations was smooth. Postoperative urograms showed satisfactory results.

Comment: Several features seem worthy of comment in this case. The most striking is the development of multiple stones within a cyst of the utricle during

FIG. 2. Case 1. *A*, plain film showing nest of small calculi which on anterior posterior and oblique cystograms (*B* and *C*) are seen to lie below and behind bladder neck.

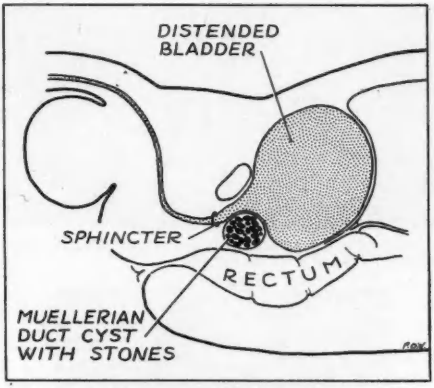

FIG. 3. Diagram of findings in case 1.

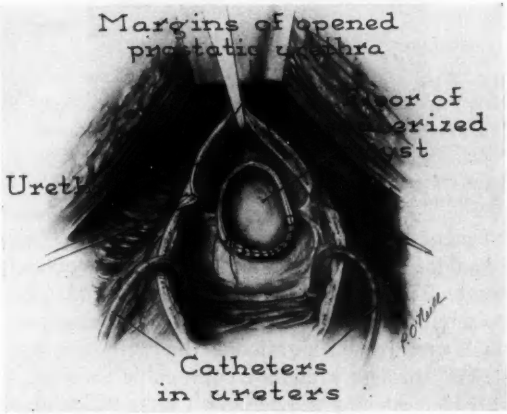

FIG. 4. Drawing showing operative approach and appearance after saucerization of the cyst.

the three-year interval that the child was under observation. Surgical technique was gratifyingly simple and satisfactory, and apparently has resulted in a permanent cure. In retrospect the cyst of the utricle was causing bladder neck obstruction before the final episode. The associated bilateral hydronephrosis, due to ureteropelvic obstruction, was apparently a coincidental finding unrelated to the lower tract disease.

Case 2. W. T. S., Texas Children's Hospital No. 29,994. A five-year-old child had symptoms of dysuria, suprapubic pain, pyuria and frequency and urgency amounting to incontinence of two months' duration. When first seen in January 1955 general physical examination was normal. Rectal examination revealed a tender hard mass, about the size of an English walnut, in the region of the prostate in the midline. All appropriate laboratory studies were within normal limits except for gross and microscopic pyuria with Proteus on culture. A plain

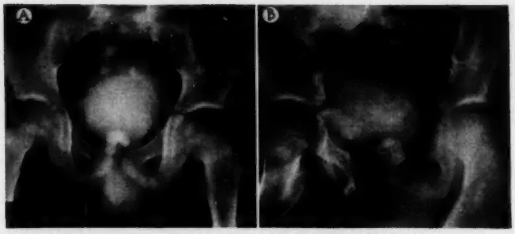

FIG. 5. Case 2. Anteroposterior and oblique cystograms. Note subvesical location of calculi subsequently found to lie in cyst of utricle.

FIG. 6. Stones have reformed in case 2, two upper ones being in bladder and lower ones in cystic cavity left behind at first operation.

x-ray, excretory urogram, and cystogram (fig. 5, *A* and *B*) showed one stone lying within the bladder and one or more stones interpreted as lying within the region of the prostate. The upper urinary tract was normal. Cystoscopy was not entirely satisfactory but a stone was seen in the bladder and a mass indented the floor of the prostatic urethra which grated as the cystoscope was passed over it. On February 1, 1955, through a midline suprapubic incision, the bladder was opened and the bladder calculus was removed, after which an additional stone was seen to have one end projecting into the urethral lumen, and the remaining stones lying in a pocket behind and above the prostate. These were fragmented in efforts at removal, but as near as could be told all were removed. No attempt was made to saucerize or obliterate the cavity, and the bladder was closed about a suprapubic tube.

The immediate convalescence was smooth but two months later, because of persistent pyuria and symptoms of cystitis, urethrography and cystoscopy were repeated. This revealed a calcification lying posterior to the prostatic urethra which represented a fragment remaining from the first operation. Treatment was directed at medical attempts to clear up the urinary tract infection. However, the child did rather poorly, and was readmitted in January 1956.

Cystoscopy on this admission showed a large diverticulum-like cavity communicating with the floor of the prostatic urethra, which contained two large calculi. Additional stones were noted within the bladder itself (fig. 6). The bladder neck was narrow and contracted.

On reviewing the entire problem, it was concluded that the primary lesion here was a cyst of the utricle with recurrent calculus formation. Accordingly, a retropubic saucerization operation was carried out. The bladder was opened and the bladder calculi removed. The floor of the bladder neck was excised and the underlying prostatic urethral diverticulum was unroofed and the calculi therein removed. The cavity was saucerized by the method described above, following which the patient made a satisfactory convalescence. The urine became clear and bladder function returned to normal.

Unfortunately the child was lost to followup for one year and on return was found to have a stricture at the bladder neck with stones again in the bladder. A Bradford Young enlargement of the bladder outlet was accomplished at which time the previously saucerized cyst had not reformed. A postoperative urethrogram showed a normal prostatic urethra and bladder neck.

SUMMARY

Two cases of children, with utricle cysts containing calculi, were operated on by retropubic saucerization technique.

The technique consisted essentially of exposing the anterior surface of the bladder and prostatic urethra through the conventional retropubic approach, just as when one does a Burns or Bradford Young bladder neck revision. After opening the bladder low down and extending the incision into the prostatic urethra, visualization was excellent, and the cyst was deroofed, the calculi extracted and the margins of the cyst lining, forming the floor of the cyst, were sutured to the adjacent mucous membrane of the normal prostatic urethra and trigone. Care was taken in each instance that saucerization was complete and no "pockets" remained. Bladder neck contracture was present in both instances, and this was corrected simultaneously with the saucerization of the cyst. Indwelling urethral catheter drainage for five to seven days with routine wound closure completed the procedure.

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DISCUSSION

DR. EDGAR BURNS (New Orleans, La.): I would like to discuss Dr. Culp's presentation and will confine my remarks to fistulas.

The occurrence of a fistula following an operation for hypospadias, regardless of the method used, is an unpleasant complication. It always means a considerable delay in obtaining a final good result. We have completed 39 patients with hypospadias using strictly the Denis Browne procedure. Fistula occurred in 24 per cent of these. These cases have been carefully reviewed, both from the standpoint of the operative technique and postoperative treatment, in an effort to determine the reason for the fistula and, if possible, to establish means of preventing its occurrence.

There are several steps in the procedure that are important. First of all, the strip of intact skin must be wide enough to provide a new urethra with a diameter at least equal to that of the proximal normal urethra. Secondly, the dorsal slit should be carried back well beyond the base of the penis and the margins separated sufficiently to provide complete relaxation of the lateral flaps. Thirdly, the tension sutures should not be too tight; otherwise, edema in the postoperative period will produce enough constriction to interfere with circulation. When we first started using the Denis Browne operation we did not provide drainage to the undersurface of the flaps, depending entirely upon stab wounds lateral to the proximal end of the incision and connecting with the undersurface of the flap in order to provide an escape for accumulated serum. More recently we have inserted a Penrose drain into the urethra and believe that this may have been a factor in reducing the incidence of infection, which, of course, always contributes to failure in a plastic procedure. If irritation is noticed around the tension sutures, these should be removed. A stenotic meatus might theoretically be a contributing factor to the formation of fistula in that it constitutes a stricture in the new urethra. Obviously, all these should be corrected at the time the straightening operation is performed.

The majority of the fistulas in these cases occur at the penoscrotal junction, and we have considered the possibility of angulation at this point, with the penis in a flaccid position, constricting the circulation enough to interfere with healing, and more recently we have attached the glans penis to the suprapubic area with a suture in order to keep it in more or less a straight position. Whether or not this is a factor may be open to question, but at the same time we believe that any suggested reasons for failure in hypospadias repair should be given consideration.

DR. FRANK C. HAMM (Brooklyn, N. Y.): I would like to make a few remarks about Dr. Culp's extremely interesting presentation of hypospadias and its treatment. In the course of the Denis Browne technique a dorsal slash is made in order to create what is really a sliding graft that permits most of the skin on the shaft of the penis to gravitate ventrally and thereby relieve tension on the suture line. I would suggest that the defect on the dorsum of the penis be filled

with a split thickness skin graft. We have noted that when the graft is used contracture of the otherwise denuded area is reduced and there is less tension. We feel that the contracture tends to put stress on the suture line and perhaps contribute to fistula formation.

Dr. Davis has done wonderful work on regeneration of the ureter. He deserves great credit for stimulating interest in this subject. Dr. Davis has contributed generously to the teaching of urology in general. I was in Philadelphia a year ago and learned that there were more medical students from Jefferson who specialized in urology than from any other medical school in Philadelphia. Dr. Davis has presented many good results with his technique. My objections to the use of a splinting tube are, first of all, that these tubes have the effect of exposing the epithelium of the urinary tract to the outside world and therefore infections, usually with drug resistant organisms which are always present in abundant quantities on the patient's clothing and bed sheets, have ready access to the kidney. Secondary strictures form not only at the site of the anastomosis but they may also occur at the end of the splinting tube. Weaver, as a result of his experimental work on dogs, states that strictures formed when large splinting tubes were used. So therefore he preferred the smaller sizes and of course the smaller sizes become obstructed more easily and have their disadvantages. I also want to point out that leaving the catheter in the ureter for any prolonged period is not an innocuous thing. Schoenemann in Brooklyn reported a death resulting from erosion through the ureter and into the iliac artery as a result of leaving an indwelling catheter in the ureter for a period of six weeks during the process of treatment of a young woman for pyelonephritis of pregnancy. There are certain prerequisites for success in the incision of a constricted area in the ureter. We only employ ureterotomy in patients where the situation is thought to be unsuitable for other types of plastic repair; for example a strictured area that extends for too great a distance below the ureteropelvic juncture to allow for the more conventional types of plastic procedures such as the flap operation of Culp or the Foley Y-plasty. Also for constrictions that occur below the ureteropelvic junction, we have simply made a linear incision in these constricted areas and allow them to heal without any intubation or diversion of the urinary stream. In fact it is our belief that diversion of the urinary stream is contraindicated and that urine and normal peristalsis should be allowed to continue during the healing period. We have found that adequate lumen of the ureter will be developed. Active peristalsis and urine flowing down through this area during the process of healing probably help to keep the diameter at a normal calibre. Also the type of stricture to be incised should be considered. We do not believe that adequate regeneration will occur if the walls of the ureter at the constricted site have been completely replaced with scar tissue. Some semblance of normal ureteral wall should be present if one is to expect adequate regeneration.

If the kidney has been mobilized during the course of the operation a nephropexy should be done as the kidney tends to occupy a lower position and it should be supported in order to prevent redundancy and kinking of the ureter. It has

now been five years since we began our work on ureterotomy without intubation and we have nine patients who have gone 2½ to 5 years with good results.

MR. NORMAN GIBBON (Liverpool, England): I remember a number of years ago Dr. Granville Crabtree in Boston telling me about several instances of intubation or ureteral catheters placed in ureters during pregnancy that had resulted in erosion of the ureter into the iliac vein. I would like to discuss Dr. Davis's paper, briefly. First, I would like to cite one case of a young Army lieutenant with a solitary hydronephrotic kidney. He had operations twice upon this hydronephrosis in an effort to relieve the obstruction at the ureteropelvic junction. This was done in that limbo known as "elsewhere." The result was a total urinary fistula through the lumbar wound. The patient had ceased to pass any urine through the urethra. He had become emaciated and febrile and was the picture of despondency. We explored him surgically, and this was, incidentally, the third operation now on this kidney. It revealed a complete dissolution of the upper ureter with a gap we judged of more than an inch. Intubation as described by Dr. Davis with a French Levene rubber tube was carried out. This tube was maintained in place for 49 days. Postoperatively, a normal looking ureter resulted. The patient got well. He gained 18 pounds in the first two months, and he returned to active duty in Germany for two years.

We had an opportunity to re-study him two years postoperatively and found he still had a normal looking ureter with good function and no infection. There was no evidence of stricture and no ureteral dilatation had ever been necessary or carried out.

Dr. Davis states that smooth muscle does not regenerate longitudinally. Nevertheless, it seems possible from such an experience to bridge a sizable gap and get a satisfactory result by intubation. I agree with Dr. Davis that splinting is a selective matter. There are cases such as this where intubation is mandatory, and there are others where it may be omitted to advantage.

MR. E. W. RICHES (London, England): I would like to discuss Dr. Prather's most entertaining paper. I was so pleased to find how little difference there is between your country and ours. In Great Britain, urology has not yet acquired the same independence that it has here, but it is regarded as a splinter specialty of general surgery. In the larger centers, specialization, some exclusive urological specialization, obtains, but in the smaller towns throughout the country, urology is usually done by a general surgeon, who has shown a special interest in urology, and we are encouraging him to develop urological clinics. In due time, he will find himself 90 per cent or 95 per cent complete urologist, owing to the demand of the patients, largely. They want to go to a man whom they know as a specialist. For the same reason, in the British Association of Urological Surgeons, we have two categories of members, full members who are exclusive urologists, and associate members who are general surgeons with that particular interest. We do demand a full training in general surgery for three or four years before a man does another two years in urology as a subject for which special training is necessary, although the Ministry of Health does not include urology in one of the lists of full specialties. The Royal College of Surgeons has also encouraged

the development of all specialties by providing a joint secretariat which gives office accommodation and secretarial facilities for all the specialties; perhaps a dozen different specialties have their offices there, but it also insures by the same method keeping them all under the wing of general surgery.

DR. GUSTAV LEANDER (Stockholm, Sweden): In connection with Dr. Boyd's paper, we usually do a urethrocystogram before operation. You get an outline of the posterior urethra together with the bladder neck, and there are times when you can see signs of inflammatory processes and some adherent mucus due to some infections of the prostate and seminal vesicles. The changes shown may not be seen through a cystoscope or endoscope. It may be that these inflammatory processes can be associated with those very unpleasant occurrences of which Dr. Boyd has spoken. We see in the urethrocystogram an opportunity perhaps to avoid these infections postoperatively.

DR. FRANK HINMAN, JR. (San Francisco, Calif.): I don't want to get caught between Dr. Davis and Dr. Hamm on the indications for the use of splints, but their place probably lies somewhere in between. It certainly has helped us, from our experimental work, to think in terms of what the basic healing process is. I can see such confusion entering in the case, which was cited in which the splint was removed in eight days, used as an illustration that splints are not needed. From the experimental work, it is obvious that epithelization if of first importance, and may take less than a week. The subsequent process of muscular healing is secondary to this. It was our observation that you need to have perfect primary epithelization. If you don't have it, you get fibrosis.

The various factors that disturb epithelization have been brought out: poor drainage, too long a gap, and so on. If, in each of our cases as we see them in the operating room, we look at the ureter and say, "What sort of process is the epithelium going to have to go through?" "What adverse factors is it going to contend with until it reforms the tube?" then we can decide whether we can leave it merely with a drain to the area or whether we have to provide a splint to direct epithelialization so as to reform a tube. Then, as we have seen, the muscle will form its little pyramids from the old edges and subsequently reform a normal ureter.

DR. SAMUEL A. VEST (Charlottesville, Va.): I would like to make a comment about Dr. Spence's paper. I think he handled his cases masterfully. I too have had a little experience with the müllerian duct cyst which might be of interest. My cases have all been in adults.

About ten years ago, we had two cases in close succession in which we went in with a transurethral instrument and deroofed the cyst taking out the floor of the prostatic urethra including the neck of the bladder and then making a wide aperture. This relieved the symptoms which were sexual and perineal discomfort, et cetera. Soon afterwards, a young man came along and we did precisely the same operation. His postoperative course was quite different, and he consistently formed large stones in the created urethral diverticulum or cyst cavity.

Another case was of unusual interest. One of the residents brought his father

in with a large benign prostatic tumor. After removing the benign portion suprapubically, I realized that the bed of the prostatic urethra was elevated and rather soft. A quick finger in the rectum revealed a large mass between the rectum and the entire floor of the bladder and the remaining prostatic capsule. I made a longitudinal incision in the floor of the prostatic urethra and entered a large walled cyst cavity. The cavity was large, between a large orange and a small grapefruit. There was a large papillary tumor within this cavity, which was removed in many pieces and sucked out. We inspected the cavity, and we could see where it originated from the floor. A section revealed a low grade papilloma. This was an elderly individual, and radical surgery was not indicated. It seemed from the experience of the last case, which began to form stones after meddling with the cyst, that we would have quite a diverticulum running back under the bladder, which would be unwise to incise.

I then closed the floor of the prostatic urethra after fulgurating the base of the tumor and made a stab wound through the perineum into the cyst for drainage. Three years later, he was seemingly well without recurrence of tumor in the collapsed cystic cavity.

DR. MEREDITH F. CAMPBELL (Miami, Fla.): In surgery of hypospadias I have found the administration of antihistamine drugs most helpful in the combat of the inevitable postoperative edema. I have used chlortrimeton and phenergan, and for about four days postoperatively. I have also used the antihistamines in scrotal surgery for the same reason. Should you see fit to try it, I am sure you will find postoperative tissue swelling and edema diminished.

DR. JOHN K. LATTIMER (New York, N. Y.): I would like to comment on Dr. Prather's paper. I have had the opportunity to work on "Urology As Others See It," under both systems, one where the Department of Urology was a splinter department, where the administration was done by a chief of surgery, and, again, in a Department of Urology which was completely autonomous and did all of its own administration. There is absolutely no doubt in my mind that the independent, autonomous arrangement is far the better.

For instance, if a situation comes up where some broad decision as to surgical policy or training methods or laboratory facilities arises, the Department or Urology is handed a decidedly secondary role. It is considered only after the Department of General Surgery has been taken care of. As far as departmental funds or research funds, are concerned, if you are dominated completely by the Department of Surgery, again, you get secondary consideration.

As to the administrative burdens, it is true that when you have autonomy, you have more administrative chores. On the other hand, this burden is not severe and is well worth the rewards. We urologists across the country compare notes a good deal. Some of us have autonomous departments and some are under chiefs of surgery. It seems to me, in our discussions, that the administrative burdens are of the same order of magnitude under both systems.

I do think it is vital to co-operate with the Department of General Surgery, and one does have a problem with house officers tending to be very provincial and standing upon their rights to do all of the cases of this or of that. It is a

bit difficult to persuade them that working with the Department of Surgery, with the surgical residents, will get them a lot more education, and a lot more cases in the long run.

It is your interest in your own department that counts. It isn't what anybody prescribes for you as your duties. But I do think that if it is decided that there is an advantage in autonomy, it is up to our specialty groups, such as the American Association of G-U Surgeons, the American Urological Association and the American Board of Urology, to come out with a very definite statement that we favor autonomy or increased independence rather than to coast along accepting things as they are thrown to us.

Dr. Montague L. Boyd (Atlanta, Georgia): I would like to make it clear that in these patients upon whom I operated no urethral obstruction was present before the operation. Some years ago I had an unpleasant experience in which a patient was prepared for transurethral resection by the other members of my staff. When I went to operate on him, I couldn't get the electrotome through his urethra because of urethral strictures. From that experience I learned the necessity of calibrating the urethra before operation. In all of these patients a 28 or 29 bougie passed easily. In one patient, a 32 bougie passed through very easily; the urethra was wide open and loose.

The other point to establish, this is not the ordinary urethral stricture that occurs after transurethral resection. What in the world we are doing with this complication in Atlanta and not elsewhere, if that is the case, I do not know.

Dr. David M. Davis (Philadelphia, Pa.): May I see the seventh slide? This demonstrates some of the points. This woman had both ureters tied during a hysterectomy. The right kidney was not relieved of its complete occlusion until seven weeks later. In each side, the ends of the ureter were freshened in oblique fashion and fastened together with one small suture of plain catgut. Since it is possible for the ureter to reconstitute around a splint in circular fashion, and it actually did so, there was no longitudinal defect to fill in.

An intravenous urogram we did several months later showed kidneys that looked normal, and the woman has been perfectly well ever since, a period of six or seven years.

The incision of scar tissue in performing intubated ureterotomy is an interesting point. Actually, the very first operation of intubated ureterotomy was done by Dr. Edward L. Keyes, Jr., who incised through scar tissue in the case of a person who had a chronically and severely infected solitary kidney. The tube was kept in place only a few days. The patient was living and well 23 years after the operation.

In the case described by Mr. Gibbon, I wonder whether the ureter was completely destroyed in that strictured area near the pelvis. Possibly in the scar tissue there was incorporated some of the muscular elements of the ureteral wall. Certainly good results can sometimes be obtained in such situations, although one would not do it purposely.

As far as the erosion of the iliac artery is concerned, that is one of the principal reasons why I personally have never used polyethylene splints. They are too

stiff. Any splint tube that is passed through the ureter should be extremely flexible so no undue pressure would be generated at that point.

If I might say one more word about Dr. Culp's paper, I have recently written a chapter on hypospadias for Hans May's book on plastic surgery. There are many techniques by which excellent results can be obtained, and I don't think we should say such surgery is particularly difficult. I am glad to know, from what Dr. Culp and Dr. Burns have said, that we have now reached a point where hypospadias surgeons are willing to admit that they do get fistulas and that they know how to cure them.

DR. HARRY M. SPENCE (Dallas, Texas): Dr. Hamm very properly raises the question of terminology of these lesions I have been talking about. Synonyms might be "a cyst of the prostate," "diverticulum of the prostatic urethra," "cyst of the utricle" or "müllerian duct cyst." I think using the term "cyst of the utricle" localizes the lesion and suggests its pathologic nature. At times it may be extremely difficult to tell what we are actually dealing with here because more often than not the structure is complicated by infection or distortion by previous instrumentation. Where stones are present within the cyst of the utricle it is not unlikely that at times a stone may erode through and be extruded into the lumen of the urethra and present as urethral calculus.

The main thing I wanted to bring out in the paper was the principle that the lesion is in reality a poorly draining cavity which must be eliminated to obtain a satisfactory result. One way to eliminate the poorly draining cavity is to "saucerize" it. In children the retropubic approach permits a simple and satisfactory obliteration of the cavity.

Certainly, in my two cases, the stones are not prostatic calculi as we customarily think of them.

Dr. Vest's comment that a transurethral resection of the roof of the cyst may give a satisfactory result is entirely correct. Certainly in children and in larger cysts in adults I believe the retropubic approach described, however, may be preferable.

FACTORS IN THE PROGNOSIS OF CARCINOMA OF THE KIDNEY

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While the urologist is naturally most interested in diagnosis and treatment it is also important for him to have a knowledge of prognosis, even if only to explain to the relatives the likely outcome of his successful operation. In adenocarcinoma of the renal parenchyma, to which my remarks will be confined, there is general agreement, in the different series which have been reported, on the average survival rate after a stated period. Thus in 395 cases reported by Priestley (1939), in 103 cases reported by Griffiths and Thackray (1949) and in 685 cases of the British Association of Urological Surgeons series (Riches, Griffiths and Thackray 1951) it was found that about 50 per cent of patients survived for 3 years, about 40 per cent for 5 years and about 20 per cent for 10 years. The prognosis in the individual case, however, varies widely and while one may die early, another may live for 20 years or more; even if untreated the average 3-year survival rate is about 3 per cent. While there can be no mathematical accuracy in such a matter it is possible after a complete study of all the factors concerned to give a prognosis which is at any rate more accurate than a racing forecast. These factors are 1) the histological grade of the tumor, 2) involvement of the renal vein, 3) invasion of lymph nodes, 4) local extension of the growth, 5) presence of metastases and 6) the method of treatment.

In an attempt to assess the relative value of each of these factors I have been through the records of 84 personal cases. Eight (10 per cent) were inoperable leaving 76 in which all the factors were known after operation. The operative mortality was six (8 per cent). Although 25 of the patients were living from 5 to 10 or more years after operation I have limited my report to those surviving for 5 years in order to have a reasonable number on which to base conclusions. Of the 76 patients, 54 were operated upon five or more years ago, and these form the basis of the survival tables.

HISTOLOGICAL GRADE

The grading is based solely on the microscopic appearance of the tumor. Of the two common types of well differentiated carcinoma the tubular adenocarcinoma is usually composed of clear cells and has well marked tubules resembling those of the kidney; the papillary cystic adenocarcinoma shows cystic spaces full of branching papillary processes: its cells are often granular, but any one tumor may contain both clear and granular cells in different areas and the type of cell appears to bear no relation to the malignancy. Both of these tumors would be classed as grade 1 if they are well differentiated. If the tubules or papillary processes are not well formed, or the cells are moderately irregular and show some mitotic activity, the tumor will be placed in grade 2. If there is no attempt at the formation of tubules or papillary processes, but marked variation in the size and staining of the cells and their nuclei, with considerable

TABLE 1. *April 1957*
Total 84. Inoperable 8 (10%)

Nephrectomy	76
Grade 1	37
Grade 2	24
Grade 3	15

Operative mortality 6 (8%).

TABLE 2. *5-year survival, April 1957*

	Possible	Actual
Total	54	27 (50%)
Grade 1	24	17 (71%)
Grade 2	18	7 (39%)
Grade 3	12	3 (25%)

mitotic activity, it falls into grade 3. It is obvious that the grading must be done by a skilled pathologist accustomed to this work and I have been fortunate in having the help of Dr. A. C. Thackray for this purpose. Neither the size of the tumor nor its gross appearance gives any real clue to the histological grade.

Table 1 shows the number of tumors in each grade in this series.

Table 2 shows the number of those who survived for 5 years. The rising scale of histological malignancy is reflected in a falling survival rate. Although some of these figures are too small to be expressed as percentages, they correspond closely with the figures we reported in the previous series, although we now have one 10-year survivor in grade 2 and two in grade 3.

INVOLVEMENT OF THE RENAL VEIN

It is well known that these tumors invade the radicals of the renal vein early and extend into its main trunk and thence to the vena cava. Involvement of the vein is here intended to mean macroscopic invasion of the main trunk or its tributaries. It occurred in 30 per cent of the operable cases in this series.

In table 3 it will be seen that venous involvement was less common in the low grade tumors than in those of the higher grades of malignancy, and there is an undoubted correlation between the two factors.

One quarter of the possible 5-year survivors with the vein involved did actually

TABLE 3. *Involvement of renal vein*

	No.	Vein Invaded
Total	76	22 (30%)
Grade 1	37	5 (13%)
Grade 2	24	11 (46%)
Grade 3	15	6 (40%)

TABLE 4. *5-year survival. Vein involved*

Total	4 out of 16 (25%)
Grade 1	1 out of 3
Grade 2	2 out of 7
Grade 3	1 out of 6

live for this period, but the figures are too small to justify any conclusions. If the whole series is examined however, we find that out of the 22 with venous involvement no less than 14 (64 per cent) died ultimately from metastases, and if the three operative deaths in this group are excluded the percentage dying from metastases rises to 14 out of 19 or 74 per cent. It is thus evident that venous involvement has a very sinister effect on prognosis. From the practical point of view it is important to try and divide the renal vein beyond any palpable growth, and it is sometimes worthwhile to open the vena cava and extract any tumor embolus within reach. One patient in whom this was done returned to work and lived for over 4 years before dying of a recurrence.

INVASION OF LYMPH NODES

Palpable invasion of lymph nodes occurred in six patients in this series, of whom two survived for five years. Lymphatic invasion does not appear to have any connection with the grade of the tumor as it occurred in 8 per cent of each of grades 1 and 2 and 7 per cent of grade 3. It is an indication for postoperative x-ray therapy, and we have found that the response to treatment is generally good. Eventually however, in five of the six cases metastases developed. A man of 62, with a grade 1 tumor, from whom invaded glands adherent to the vena cava were removed, lived for four years before dying of recurrence in the lung. A woman of 37, with a grade 2 tumor, had a mass of glands adherent to the aorta which I could not remove; they disappeared under x-ray treatment but recurred in the neck and disappeared again with treatment. They recurred here again and I excised them. She remained well for nearly six years before dying from multiple metastases. Another patient, whose glands were removed at the time of operation, lived for 7½ years before dying from carcinoma of the stomach. Although lymphatic invasion is an important factor in prognosis it does not appear to have such an early lethal effect as a high grade of tumor, but locally invaded lymphatics should always be removed with the kidney if possible.

LOCAL EXTENSION

By local infiltration the tumor may invade the perinephric fat, the surrounding muscles, the colon, the pancreas or other viscera (table 5).

It occurred in 24 per cent of the whole series and was more evident in the higher grades of tumor. Its effect on survival cannot always be anticipated but it is an obvious indication for x-ray treatment either before or after operation. If there is clinical evidence of local fixity it is worthwhile confirming this by perirenal oxygen insufflation, and preoperative x-ray therapy will sometimes make a fixed tumor operable. One such patient, with a grade 2 tumor and the

TABLE 5. *Local extension*

	No.	Present	5-Year Survival
Total	76	18 (24%)	5 out of 9
Grade 1	37	5 (13%)	2 out of 3
Grade 2	24	7 (29%)	2 out of 2
Grade 3	15	6 (40%)	1 out of 4

TABLE 6. *Metastases present at operation*

		Present
Total	76	7 (9%)
Grade 1	37	3 (8%) Bones 3
Grade 2	24	3 (13%) Lungs 2, bones 1
Grade 3	15	1 (7%) Liver 1

Longest survivor living and well at 4 years.

vein involved, is alive and well five years after operation. Another, a man of 47, was explored elsewhere and found to have a fixed inoperable renal tumor. He took a course of x-ray treatment and the tumor became smaller. I then re-explored, divided some adhesions and removed the kidney. He remains well more than 10 years later although it was a grade 2 tumor with the vein involved.

METASTASES

Even in the presence of known metastases it is sometimes advisable to perform nephrectomy, either to relieve pain or hematuria, to control pyrexia, or on the assumption that x-ray treatment of a secondary deposit will be more effective if the primary growth has been removed. See table 6.

In only one of these patients have I found it possible to remove the metastasis after removing the kidney. This man of 65 had a grade 1 tumor with the vein free; five weeks after doing the nephrectomy I removed part of his chest wall which showed a similar growth in the seventh rib; he remains well four years later. It is well known that in this disease the metastasis is sometimes solitary; the possibility of its removal should always be borne in mind. The preoperative detection of a metastasis in the liver was made in one case by aortography; it showed not only an area of pooling in the kidney but another in the liver, fed by a branch of the hepatic artery; it was palpated at the time of left nephrectomy but unfortunately appeared too large for successful extirpation.

METHOD OF TREATMENT

Some of the possibilities of preoperative x-ray treatment have already been mentioned and it is open to question whether the results in general could not be improved by a more extensive application of this form of therapy. Regarding postoperative x-ray treatment we found, in the analysis of the larger series of cases previously reported (1951), that the survival rate was increased in those

TABLE 7. *Incidental finding of carcinoma*

	No.	Nephrectomy for	Survived 5 Years
Grade 1	4	Calculi	3
Grade 2	2	1 hydronephrosis, 1 hypertension	1 1
Grade 3	1	Suspected calculus	0
Total	7		5

patients who had received postoperative treatment. Moreover, the increase was most marked in those tumors, generally of high grade malignancy, in which the vein was involved. There are often cogent reasons for not giving x-ray treatment to a particular patient, but I believe that it should be given in all tumors of high grade, in those where the vein is involved, where lymph nodes are invaded or where there is evidence of local extension.

The surgical treatment should be radical and should include the removal of the perinephric fat, invaded glands and, if necessary, other viscera. Exposure must be adequate, and the approach used is usually through the bed of the excised twelfth rib. Occasionally the Nagamatsu incision is used and in a few instances the abdominothoracic approach.

When all is said however, we must realize that the key to successful results is early diagnosis. With the aid of aortography we have been able to diagnose the presence of a tumor less than one inch in diameter. There have also been 7 patients in whom the finding of a new growth was accidental, the kidney being removed for some other reason (table 7).

Five of the seven have lived for more than 5 years. A grade 1 patient died from pulmonary embolism, and a grade 3 patient whose kidney contained the smallest tumor I have ever removed was back in less than 2 years with extensive metastases.

The longest survivor in the whole series, a woman of 48, is alive and well more than twenty years after operation. It was a grade 1 tumor with the vein free, and it was enclosed in a calcified shell.

There must be an exception to prove every rule; in this series it is provided by a man of 60 who was investigated for loss of weight and was found to have a grade 3 tumor with the vein invaded and extension of growth into the perinephric fat. He is alive and well more than 8 years after operation.

SUMMARY

The factors influencing the prognosis in carcinoma of renal parenchyma have been considered in a series of 84 cases, of which 76 were treated by nephrectomy.

The histological grade of the tumor is the most important factor, and involvement of the renal vein has a serious adverse influence.

Surgical excision must be radical and early to have a chance of permanent success.

X-ray therapy either before or after operation has a place in treatment and increases the survival rate.

The probable outcome of an individual case can be foretold with reasonable accuracy when all the factors are known.

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MALIGNANT NEOPLASMS OF THE KIDNEY: AN ANALYSIS OF 353 PATIENTS FOLLOWED FIVE YEARS OR MORE

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It is the purpose of this report to present an analysis of 353 patients with malignant neoplasms of the kidney confirmed by microscopic tissue study and followed for five years or more by the Tumor Clinic at the University Hospitals in Iowa City, Iowa. These patients were seen during the period 1926–1950, inclusive. These tumors were classified as follows:

Renal cell carcinoma	305
Embryoma (Wilms' tumor)	31
Tumors arising from renal pelvis (epidermoid and transitional cell carcinomas)	17

They were staged on the basis of the extent of the primary lesion as follows:

Stage 1—Limited to the renal capsule
Stage 2—Invasion of the renal pedicle and/or renal fat
Stage 3—Regional lymph node involvement
Stage 4—Distant metastasis demonstrable

Two hundred and forty-three of these patients were seen prior to 1946 and thus enabled us to obtain the results of a 10-year or more followup study. These were classified as 220 renal carcinomas; 22 embryomas; and 11 tumors of the renal pelvis.

RENAL CARCINOMA

Three hundred and five cases of renal carcinoma were analyzed. One hundred and sixteen of these were in stage 4 and 21 cases were not staged. Fifty-two received only palliative treatment due to advanced age or general debility and these were not considered as treated cases. Of the 137 treated cases, four were of unknown stages but were included in all the studies except those related to stage of the disease. Tables 1 to 5 summarize the results of these analyses. Treatment, when used alone in these tables, means an attempt to destroy the tumor by nephrectomy, irradiation, or a combination of nephrectomy and irradiation.

Table 1 gives the five- and 10-year survival according to the stage at the time of the diagnosis and compares the treated cases with the over-all group in the various stages. Twenty-one cases were not staged and therefore are not included in this table.

It is to be noted that the five- and 10-year survival is very definitely improved by the institution of therapy in all stages studied. In stage 1, 16 patients received no therapy. Of these only two survived, making a five-year survival of 12½ per cent as contrasted to 55 per cent in the treated cases. Similarly, of the 10-year cases one of 14 survived, making a 7 per cent 10-year survival as contrasted with a 23 per cent survival in the treated cases. For stage 2 cases a similar analysis shows a 14 per cent five-year survival for the untreated as contrasted to a

TABLE 1. *Renal carcinoma*

	Followup	Number of Cases	5-Year Survival	10-Year Survival
Stage 1, over-all	5-year	76	35 (46%)	
	10-year	58	23 (40%)	11 (19%)
Treated cases	5-year	60	33 (55%)	
	10-year	44	22 (50%)	10 (23%)
Stage 2, over-all	5-year	59	22 (37%)	
	10-year	47	18 (38%)	12 (28%)
Treated cases	5-year	52	21 (40.5%)	
	10-year	42	17 (40.5%)	11 (25.5%)
Stage 3, over-all	5-year	33	3 (9%)	
	10-year	21	2 (9.5%)	2 (9.5%)
Treated cases	5-year	21	3 (14%)	
	10-year	12	2 (16.6%)	2 (16.6%)
Stage 4	5-year	116	4 (3.5%)	
	10-year	79	3 (3.8%)	1 (1.3%)

TABLE 2. *Renal carcinoma*

	Followup	Number of Cases	5-Year Survival	10-Year Survival
Total cases	5-year	305	71 (23%)	
	10-year	220	48 (22%)	27 (12.3%)
Treated cases*	5-year	137	41.1%	
	10-year	101	40.6%	22.8%
Treated by nephrectomy*	5-year	56	48.2%	
	10-year	39	46%	23%
Treated by x-ray plus neph.*	5-year	40	52.5%	
	10-year	27	55%	33.3%
Treated by x-ray only*	5-year	41	24.4%	
	10-year	35	23%	14.5%
No treatment*	5-year	50	10%	
	10-year	40	12.5%	5%
Treated by x-ray pre-op-then neph.	5-year	25	(13) 52%	
	10-year	14	(8) 57%	(7) 50%

* Cases in stages 1, 2 and 3.

40 per cent survival for the treated; and, similarly, a 20 per cent 10-year survival as contrasted to a 25 per cent survival in the treated cases. In stage 3 the contrast is even more marked. There is a zero per cent survival in the untreated cases as contrasted to a 14 per cent five-year, and 16 per cent 10-year survival. These figures would seem to indicate that in those patients where therapy was utilized the prognosis was better either because of the intrinsic nature of the situation or because of the therapy itself. Moreover, it would seem that there is little difference between stages 1 and 2 as far as prognosis is concerned; but the results in stages 3 and 4 were definitely worse.

Table 2 illustrates the effects of the various types of therapy upon survival. It demonstrates again the marked improvement in survival in the treated cases as contrasted to the untreated cases. It is of interest also to note that the combi-

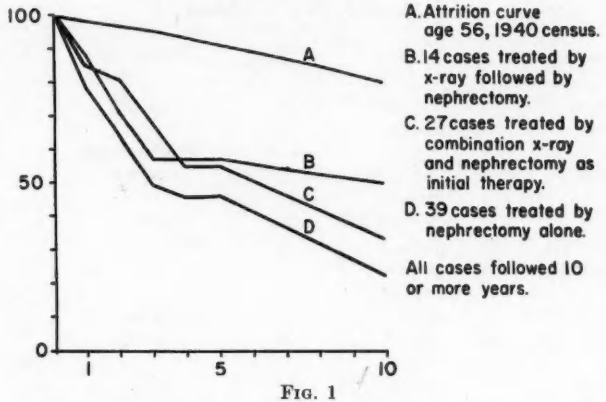

FIG. 1

nation of nephrectomy and irradiation produces what seems to be significantly better results than nephrectomy alone. The total number of cases is small but the difference particularly in the 10-year survival group is so marked that it may be of real significance. Figure 1 illustrates the difference between nephrectomy alone and the combined treatment cases as far as 10-year survival is concerned. It shows that those of the combined treatment group who have passed the five-year mark have a mortality which is no greater than that of the general population. It is also of interest to point out that the only two patients in stage 3 who survived 10 years and the one case in stage 4 that did so received irradiation as part of their therapy. Table 3 shows an analysis of survival related to staging in the 25 patients who received preoperative irradiation followed by nephrectomy. We want to emphasize the 10-year survival figures in this group. These patients all received approximately 7000 roentgens through several ports over a period of three weeks. Six weeks later nephrectomy was carried out. Irradiation therapy seemed to have shrunk some of the dilated veins and made the nephrectomy in no way more difficult. Aside from shrinkage of collateral circulation no other unusual gross or microscopic changes in the tumor were noted in these patients at the time of operation.

TABLE 3. *Renal carcinoma*

Treated by X-Ray Pre-op followed by Nephrectomy	Followup	Number of Cases	5-Year Survival	10-Year Survival
Stage 1	5-year	9	6 (66.6%)	
	10-year	5	2 (40%)	2 (40%)
Stage 2	5-year	12	7 (58%)	
	10-year	8	6 (75%)	5 (62.5%)
Stage 3	5-year	3	0 (00%)	
	10-year	1	0 (00%)	0 (00%)
Unknown stage	5-year	1	0 (00%)	
	10-year	0		

TABLE 4. *Renal carcinoma*

Author, Date	Followup	Number of Treated Cases	5-Year Survival	10-Year Survival
Bergendal, 1936	5-year	57	40.4%	
	10-year	40		30%
Beer, 1937	5-year	?	Apparent 34%	
Priestley, 1939	5-year	357	38.4%	
	10-year	253		27.3%
Melicow, 1943	5-year	20	50%	
Bixler, et al., 1944	5-year	64	35.5%	
Foot, et al., 1949	5-year	37	41%	
	10-year	17		23%
Dick and Flint, 1951	5-year	36	46%	
Throckmorton, 1955	5-year	22	36.3%	
	10-year	14		14.5%
Goldstein, 1956	5-year	77	31%	
This series, 1957	5-year	137	41.1%	
	10-year	101	40.6%	22.8%

TABLE 5. *Renal carcinoma*

Duration of Symptoms	5-Year Survival	
	Over-all	Treated cases
Less than 1 month	31%	60%
1–6 months	16%	24%
7–12 months	12%	16%
1–2 years	11%	27%
2–3 years	35%	43%
3–5 years	31%	50%
5–10 years	56%	64%
Over 10 years	20%	20%

It is of interest moreover to compare tables 1, 2, and 3 with table 4. Table 4 is a summary and comparison of five- and 10-year survivals of patients with renal carcinoma as reported in the literature by various investigators of the past 20 years. It would seem that the over-all results with the exception of the small group receiving combined therapy have been essentially the same at various times and in various hands.

Table 5 gives the percentage survival according to the duration of symptoms prior to institution of symptoms. These figures were analyzed to obtain further information with regard to the life history of this tumor. Their significance is not clear. They are simply presented for the record.

EMBRYOMA (WILMS' TUMOR)

There were 31 embryomas of the kidney in this series. All but three received treatment. Table 6 summarizes the results in our series and compares these with others reported in the literature. It is to be noted that our two-year survival in the 14 cases treated by preoperative irradiation followed by nephrectomy is

TABLE 6. *Wilm's tumor*

Author, Date	Followup Period	Number of Cases	2-Year Survival	5-Year Survival	10-Year Survival
Priestley,* 1939	3-year	17	4(23.5%)	3 (23.5%)	
	5-year	15			1 (9.1%)
	10-year	11			
Ladd, 1941		60	14 (23%)		
Weisel, 1943		44	7 (16%)		
Nesbit, 1946		16	8 (50%)		
Foot et al., 1949	5-year	11		3 (27%)	
Gross and Neuhauser, 1950		38	47.3%		
Haines, 1954		18	7 (38.8%)		
This series					
Treated by x-ray only	5-year	14	4 (28.6%)	2 (14.3%)	
	10-year	10	2 (20%)	2 (20%)	0 (00%)
Treated by x-ray prep. plus nephrectomy	5-year	14	7 (50%)	5 (35.7%)	
	10-year	9	5 (55.5%)	4 (44.4%)	2 (22.2%)
Over-all	5-year	31	11 (35.5%)	7 (22.6%)	
	10-year	22	7 (32.5%)	6 (27.3%)	2 (9.1%)

* Treated cases.

† All but 2 treated with surgery plus post op. irradiation.

TABLE 7. *Tumors of the renal pelvis*

Author, Date	Followup	Number of Treated Cases	5-Year Survival	10-Year Survival
Priestley, 1939	5-year	40	14 (35%)	
	10-year	19		2 (10.5%)
Foot, et al., 1949	5-year	12	3 (25%)	
Dick and Flint, 1951	5-year	8	2 (25%)	
This series	5-year	17	7 (41%)	
Over-all	10-year	11	3 (27.2%)	1 (9.1%)
Treated cases	5-year	11	5 (45%)	
	10-year	6	2 (33%)	1 (16.5%)

similar to the two-year survival in a larger group of patients reported by Gross and Neuhauser. It is also to be noted that 2-year survival is by no means indicative of a cure. There is every indication from the study of this group of cases and from the reports in the literature such as that of Gross and Neuhauser that irradiation is an important part of the therapy of these cases. Preoperative x-ray treatment proved useful in this group of patients.

TUMORS OF THE RENAL PELVIS

There were 17 tumors of the renal pelvis and the results of an analysis of these cases are compared with some similar groups reported in the literature in table 7. Note that only one patient lived and is living 10 years after the institution of therapy which consisted of nephro-ureterectomy. No combined therapy

was instituted in this group of patients. Whether it would alter the poor prognosis is not known and deserves study.

SUMMARY

An analysis of 353 cases of malignant renal neoplasms studied at the University Hospitals from 1926 to 1950, inclusive, is presented.

With regard to renal carcinoma, combined surgical and radiation therapy seems to have given better results than simple surgery alone. Further studies are needed in this regard.

A small group of Wilms' tumors is analyzed. From this study it would seem that 2-year survival does not necessarily mean a cure of this dread disease. Moreover, combined therapy is superior to either irradiation alone or surgery alone.

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A NOTE ON PHEOCHROMOCYTOMA AND RENAL HYPERTENSION

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It seems appropriate at this time to report an unusual instance of renal hypertension due to unilateral renal disease discovered one year after the removal simultaneously of three pheochromocytomas from the same patient. It should be emphasized that pheochromocytoma commonly involves the sympathetic ganglia in the region of the renal vascular pedicle and also the adrenal gland. It is possible that in the removal of such a tumor lying in close contiguity with the renal vessels and especially when receiving blood supply from these vessels that the renal artery and vein could be implicated in subsequent cicatricial tissue which might lead to renal ischemia. The latter leads to the elaboration of rennin, a proteolytic enzyme which acts upon one of the serum globulins termed hypertensinogen by Houssay to convert it to the active vasoconstrictor agent hypertensin which causes hypertension. It seems possible also that the vascular lesions pursuant to hypertension produced by pheochromocytoma could also produce such renal ischemia and the development of persistent hypertension on this basis. We have not previously observed this phenomenon, it had not occurred to us that this sequence of events might occur and we are not aware of its having previously been reported. Since the discovery of pheochromocytoma has become increasingly common it seems especially important to call attention to the possibility of this complication occurring either from the primary vascular disease imposed by the pheochromocytoma or by compromise of the renal vascular pedicle in the dissection of a pheochromocytoma growing next to the renal artery. We have had occasion to remove two such tumors from this location in the last year and it is one of these patients described herein.

The present report concerns a single girl, aged 16 years, who at the age of three was found to have polycythemia. She was admitted to the Peter Bent Brigham Hospital in October 1955 for study by the hematologist. The hematocrit was found to be 57, white blood cells 5,300, neutrophils 59, bands 5, eosinophils 2, lymphocytes 33, mononuclears 1. Blood pressure was 266/150. A regitin test resulted in a transitory fall in blood pressure to 125/80. Study of the plasma norepinephrine showed on three determinations (table 1) a level of 9.2, 10.7 and 12.7 gamma per liter of plasma, whereas epinephrine levels were .3, 1.8 and .82 gamma per liter of plasma. Detectable amounts of rennin in the peripheral blood were found by Dr. Florence Haynes; this finding subsequently becomes of real significance. Excretory urograms showed normal renal pelves and ureters. The right renal shadow was normal, the left renal shadow exhibited a small convexity mesially in the region of the upper pole of the left kidney. In November 1955 an exploration resulted in the finding and removal of a pheochromocytoma involving the sympathetic ganglion at L-3 weighing 9 gm., another pheochromocytoma weighing 10 gm. involving the sympathetic ganglion at L-1 and receiving

TABLE 1. *Norepinephrine y/ liter plasma*

Preop.	During Op.	Postop.
9.2	23.4	4.8
10.7	19.5	4.8
12.7	21.9	2.84
Epinephrine y/ liter plasma		
.3	2.9	1.2
1.8	4.	1.2
.82	6.8	1.

blood supply from the renal vascular pedicle and a third pheochromocytoma involving the lower pole of the left adrenal gland also receiving blood supply from the renal vascular pedicle and weighing 2.5 gm. Study of these specimens showed the smaller arteries and arterioles to have hyperplastic thickening of the walls. This is anatomic evidence of systemic arterial hypertension. A lymph node outside the capsule of the second tumor was found to contain tumor cells. Simultaneous exploration of the right sympathetic chain and adrenal as well as the pelvis resulted in the finding of no more tumors.

The patient had no hypotensive episodes postoperatively and required no substitution therapy with norepinephrine. Plasma norepinephrine level fell to 4.8 to 2.8 gamma per liter postoperatively and remained within normal limits thereafter. Epinephrine levels postoperatively were 1.2 and 1 gamma per liter of plasma postoperatively and did not rise above normal thereafter. The patient's blood pressure remained elevated at somewhat lower levels than preoperatively but was usually in the range of 180/120.

She was followed closely during the ensuing year with repeated studies for evidence of pheochromocytoma and all specific tests yielded normal results in this regard. However, hypertension and polycythemia continued to persist and the symptoms of hypertension with severe headaches and signs of encephalopathy definitely progressed. Continued efforts to control these two conditions medically with serpasil, ansolysin and repeated phlebotomy were without avail. The heart remained normal in size and the lung fields clear.

She was readmitted to the hospital in December 1956. Repeated determinations of the plasma and urine catecholamines had shown these to remain within normal limits. The hypertension no longer responded to regitin.

Excretory urograms were made. The renal shadow on the right and the renal pelvis were unchanged from the previous year. The left renal pelvis and the shadow of the left kidney appeared definitely smaller. Cystoscopic examination was then carried out and divided function studies obtained as shown in tables 2 and 3. It is seen that there is a marked discrepancy in the volume of urine produced simultaneously by the two kidneys; the volume from the left kidney being much less than that from the right. Under conditions of normal hydration 20 ml. of urine were collected from the right kidney in 10 minutes and this showed a sodium concentration of 28 meq/L. Simultaneously the volume of excretion

from the left kidney was 3 ml. and the sodium concentration measured 10 meq/L. Intravenous phenolsulfonphthalein appeared in 3 minutes in excellent concentration from the right kidney and in 15 minutes in only trace amounts from the left kidney. The total 10-minute collection from the left kidney could not be measured and that from the right kidney measured 6 per cent. These determinations were made on December 11, 1956. This examination was repeated on December 29, 1956 under conditions of forced hydration with a water load. These findings are presented in detail in table 3. It is seen again that there is a discrepancy in the function of the two kidneys both as regards quality and quantity of urine excreted. From the right kidney in 15 minutes 26 ml. were collected containing 1.3 meq/L of sodium as over against only 2 ml. from the left kidney with 4.6 meq/L. These findings would indicate that under circumstances of water loading the right kidney was able to reabsorb and conserve sodium normally whereas the left kidney was much less able to conserve sodium under the circumstances of severe diuresis which indicates that the tubules of the left kidney are more independent of the normal mechanism of aldosterone sodium retention. These findings have been confirmed in the laboratory by Berliner in the presence of induced renal ischemia.

In the patient under consideration again the phenolsulfonphthalein excretion was excellent from the right and a greatly diminished excretion from the left occurred in small volume. The phenolsulfonphthalein excretion was less on the left than one would have expected from the excretory urograms made a short while before.

Significant data are obtained from a detailed study of the renal roentgenograms listed in table 4. Measurements of the renal shadows on these films show

TABLE 2. *Renal function studies (December 11, 1956). Hydration normal*

	Vol. 10′	Na/meq/L	P.S.P. Appt. T.	P.S.P. 10′
R.U.U.	20 ml	28	3′	6%
L.U.U.	3 ml	10	15′ (trace)	—

TABLE 3. *December 29, 1956. Forced hydration; water load*

	Vol. 15′	Na/meq/L	P.S.P. Appt. T.	P.S.P. 15′
R.U.U.	26 ml.	1.3	3′	26 ml. 2%
L.U.U.	2 ml.	4.6	7′	3 ml. 0.3%
Bladder	106 ml.	2.2	3′	100 ml. 17.%

TABLE 4

Renal Roentgenograms	Preop. 1955	Postop. 1956
Right kidney length	14 cm.	14 cm.
Right kidney width	6½ cm.	7 cm.
Left kidney length	12 cm.	9 cm.
Left kidney width	6 cm.	3½ cm.

that in 1955 the right kidney was 14 cm. in length and 6½ cm. in width. In 1956, one year later, these measurements are the same for the right kidney. The left kidney in 1955 was 12 cm. in length and 6 cm. in width, whereas one year later in 1956 the left kidney was only 9 cm. in length and 3½ cm. in width. These measurements are also supported by the diminution in size of the renal pelvis as demonstrated by excretory urography. With retrograde pyelography the discrepancy was less owing to the overfilling of the left renal pelvis but it is still apparent that there has been a marked diminution in renal mass in one year accompanied by progressive hypertension. Both kidneys had appeared to be normal at operation in 1955.

Since no evidence of residual pheochromocytoma could be found and since such positive evidence of unilateral renal disease on the left was present, exploration of the left kidney was planned with the intent of putting in a renal arterial graft if this seemed feasible according to the technique of Poutasse and associates or of removing the left kidney. A unilateral sympathectomy was planned because of the severity of the patient's hypertension and the desire, if possible, to save her one additional operation. If hypertension were not relieved by the renal surgery and if unilateral sympathectomy had been carried out the patient would then need only one further operation to complete a bilateral sympathectomy. Accordingly, on January 4, 1957, a transthoracic exposure of the left kidney was accomplished. The kidney was found to be encased in dense scar tissue and to be even smaller than had been estimated by measurements of the roentgenographic shadows. The renal vascular pedicle was exposed and no localized area of constriction was found. However, the entire left renal artery was small from the kidney to the aorta. The renal parenchyma was so thinned and irregular that there was no question regarding saving this kidney. Prior to nephrectomy 50 cc blood was drawn from the renal vein for rennin determination. This was found to be markedly elevated by Dr. Florence Haynes. There was also some elevation of the rennin level of the peripheral blood. There was no evidence of any residual pheochromocytoma or adrenal gland on this side. Nephrectomy was completed without incident and simultaneously a unilateral thoracolumbar sympathectomy was performed by Dr. Francis D. Moore. The patient's blood pressure fell from levels of 200/100 to 160/85 pursuant to the nephrectomy. Postoperatively the patient's blood pressure fell to 100/80 and it was necessary to maintain her tension by means of neosynephrine drip for 2 days. During convalescence the blood pressure stabilized at 120/80.

The pathologic report follows: The kidney weighed 52 gm. and had a thick capsule which was adherent to the subjacent parenchyma. The subcapsular parenchyma was finely granular, suggestive of atrophy. There were several depressed areas which proved to be partially healed infarcts. At one pole the largest of these infarcts was found and represented an area on the cut surface of about 1 by 2 cm. Except for the infarcts which were only partially organized, the cortex was uniformly atrophied and contracted to a thickness of 3–4 mm. There were no gross alterations of the medulla. There was hyperemia of the pelvic mucosa which also had scattered petechiae.

The most proximal portion of the renal arteries appeared grossly normal. However, there was prominence of the smaller branches, namely the arcuate arteries and those supplying the infarct at one pole appeared to be occluded. The veins appeared normal.

Microscopically the cortical atrophy was uniform and of advanced degree affecting as usual the tubular portions of the nephron primarily. The infarcts still had glomeruli recognizable in some degree and probably represented an alteration ranging from possibly 1 to 4 months duration.

Several arteries within and outside of the infarcts had thrombi in various stages of organization and would have corresponded to about the same duration as that of the infarcts. There was no evidence that there had been an appreciable degree of arteriolosclerosis before the atrophic process had been initiated.

Anatomic diagnoses: Atrophy of the kidney, advanced (52 gm.); multiple small infarcts, partially organized thrombi in tertiary and smaller branches of the renal arteries, partially organized and canalized.

DISCUSSION

Two processes must have been responsible for the atrophy and the infarcts. This type of uniform atrophy is usually the result of a reduction in renal arterial blood supply near the origin of the renal artery by narrowing of the lumen. Microscopically there was no lesion observed in the largest arteries in the sections. The thrombi described in the smaller branches, as aforementioned, accounted for some of the larger areas of ischemic necrosis but could not account for the uniform atrophy of the cortex. In terms of this patient's course, the infarcts are moderately recent, possibly one to four months in duration. It is more difficult to estimate the duration of the diffuse cortical atrophy, except to say that the left kidney appeared normal at operation about 14 months before it was removed and the process might have had a duration almost as long as this interval but this alteration could have taken place in a shorter period of time. Either lesion and both lesions, the infarcts and the diffuse cortical atrophy have been observed as principal lesions in kidneys thought to be the basis of hypertension when these were present as unilateral lesions.

Total renal function studies have continued to be within normal limits and three months postoperatively her blood pressure is 120/80 to 130/90 and the hematocrit is maintained at a level of 45 without phlebotomy. This case will be reported with others in detail with especial reference to both hormonal, hematologic and pathologic studies including the details of intensive followup examinations. This is the second instance in one year of removal of an ischemic kidney resulting in cure of hypertension and diminished polycythemia on this service.

SUMMARY

Attention has been called to the possibility of unilateral renal disease causing a persistence of hypertension after the removal of pheochromocytoma. The possibility of coincident pheochromocytoma and unilateral renal ischemia producing hypertension is noted and it is emphasized that the dissection and removal of

pheochromocytoma particularly in the region of the renal vascular pedicle may be followed by such a complication. If the blood pressure does not return to normal after removal of the pheochromocytoma the importance of intensive investigation of renal function with separate determinations of volume, sodium and phthalein excretion is emphasized. Repeated roentgenograms of the kidneys will detect decrease in the size of renal parenchyma and pelvis. Aortography with renal arteriograms will demonstrate the vascular changes earlier as shown by Poutasse and associates. Rennin determinations of the peripheral blood may be suggestive of primary renal hypertension under these circumstances.

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ELECTROLYTE ABSORPTION FROM FOWL'S CLOACA: RESISTANCE TO HYPERCHLOREMIC ACIDOSIS

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Although there has been extensive investigation of reabsorptive acidosis after operative diversion of the urine to the bowel, little attention has been directed to those factors which prevent the development of this condition in animals with a cloaca.[1] Since an additional approach might help to elucidate this postoperative complication, we have made studies of the absorption of electrolytes from the fowl's cloaca, and compared them with similar observations on the rectosigmoid of dogs and humans.

EXPERIMENTAL METHOD

In our experiments with cloacal absorption Rhode Island Red hens weighing 2.2 to 3.4 kg. were used.* With the birds under ether anesthesia, 10 ml. of the test solutions was injected into the cloaca. Radioactive sodium or iodine† served as tracer elements and 0.5 ml. of 0.8 per cent solution of indigo carmine was added to each instillation. Escape of fluid was prevented by closing the anus with a purse-string suture. Coloring the fluid with indigo carmine served two purposes—it facilitated detection of the slightest leakage and at autopsy it revealed the levels reached by the instilled solution in the cloaca, oviduct, ureters, and colon by staining of mucosal surfaces.

The rate and amount of absorption of electrolytes in the circulating blood were determined by measuring the uptake in 1 ml. samples of blood withdrawn from the jugular vein at intervals of from five to thirty minutes for four or five hours after instillation. At this time autopsy was performed. Observations were made of the extent of local distribution of the fluid as shown by mucosal staining. In several animals the fluid remaining in the cloaca was tested for residual radioactivity. In all the animals in which I^{131} was used, the thyroid was removed and its content of radioactive material was measured.

The amount of isotope in the blood samples and the thyroid gland was measured with a Tracerlab scintillation counter. By comparison with a standard solution, the counts per minute were converted into microcuries of isotope. The amount in the total circulating blood was calculated by using 7.3 per cent of the animal's total weight as the weight of the total blood volume.‡

[1] Weyrauch, H. M. and Hinman, F.: An experimental study of uretero-intestinal implantation. III. The significance of ureterocloacal re-implantation in the chicken. Surg., Gynec. & Obst., **70:** 170–177, 1940.

* By making blood serum determinations of chloride and creatinine in several hens we found that the normal values in the fowl coincide with those in the human. The chloride in the hens ranged from 88 to 111 meq/L., and the creatinine from 0.3 to 1.4 mg per cent.

† Absorption of chlorine and iodine from the gastro-intestinal tract, their diffusion (except in the thyroid gland) and excretion, are similar.[2]

[2] Hanzlik, P. J.: Quantitative studies on the gastro-intestinal absorption of drugs. II. The absorption of sodium iodine. J. Pharmacol., **3:** 387–421, 1912.

‡ This percentage was arrived at by calculating the blood volume in four hens using the

Total transcloacal absorption was determined by adding the amount of isotope in the circulating blood to that in the extravascular tissue spaces, and to that contained in the thyroid in the iodine experiments.*

Series 1. In an initial series of 20 hens absorption of iodine and chlorine in various concentrations of fluid was observed. The following solutions, each containing 250 microcuries of isotope, were instilled in the cloaca of four groups of five hens each:

A) I^{131} in a hypotonic solution (less than 0.1 per cent) of NaI yielded a mean of 7.5 per cent absorbed (fig. 1, *A*).

B) I^{131} in an isotonic solution (0.9 per cent) of NaI yielded a mean of 5.6 per cent absorbed (fig. 1, *B*). In one of the hens 92 per cent of residual isotope was recovered from the cloaca.

C) I^{131} in a hypertonic solution (2 per cent) of NaI yielded a mean of 6.7 per cent absorbed (fig. 1, *C*).

D) Na^{24} in an isotonic solution (0.9 per cent) of NaCl yielded a mean of 10.7 per cent absorbed (fig. 1, *D*). In two hens 91 and 88 per cent of residual isotope was recovered from the cloaca.

Figure 2, *A* demonstrates the mean absorption of all electrolytes placed in the cloaca in various carriers. The absorption rates, ranging from 5.6 per cent to 10.7 per cent, showed little difference between the various concentrations of fluid.

As concerns the rate of absorption, within five minutes after instilling the isotope there were measurable amounts of radioactivity in the blood obtained from the jugular vein. In most of the birds, maximum absorption was reached one and one-half to two and one-half hours after cloacal instillation. Thereafter the blood levels remained nearly constant. Apparently by this time equilibrium was established between cloacal absorption, tissue space distribution, and urinary excretion of the tagged electrolyte back into the sealed cloaca. By this time, too, in the I^{131} experiments, saturation of the thyroid with the iodide ion was ap-

dilution method of radioactive iodinated serum albumin. This percentage closely coincides with values previously reported for chickens by dye dilution and diphtheria antitoxoid methods.[3-5]

* It can be assumed that the chicken has sodium and chloride (iodine) spaces similar to that in the dog, or human, where they have been carefully studied and found to approximate 28 per cent of the total body mass.[6, 7] Given the isotope content in the circulating blood, the blood being 7.3 per cent of the chicken's body weight, approximately four times this amount is the total tissue space content of sodium. Similarly four times the blood amount plus the thyroid content would be the total tissue space for iodine. It is confirmatory that in the three hens in which residual isotope was measured in the cloaca at the termination of the experiment, 88 per cent, 91 per cent, and 92 per cent of the isotope was found unabsorbed.

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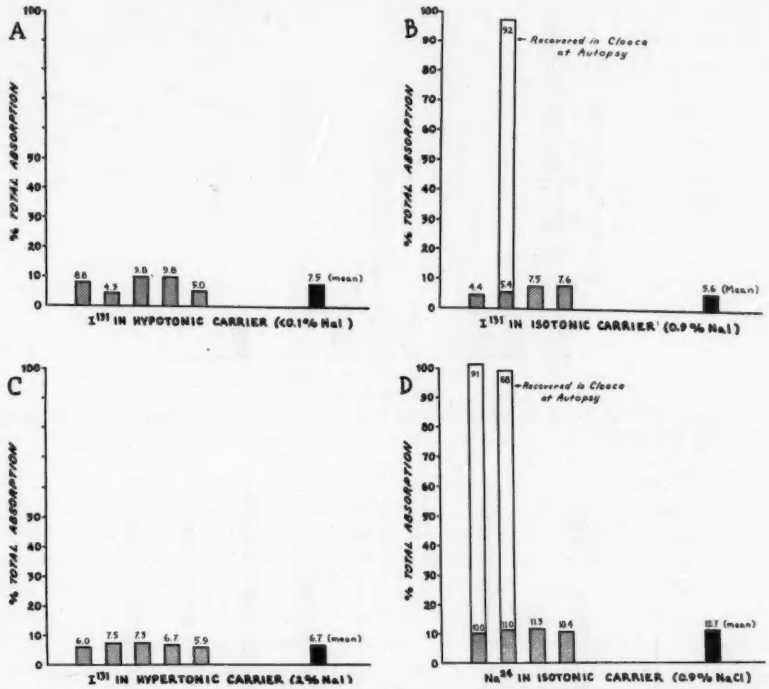

FIG. 1. *A*, amounts of I^{131} in hypotonic solution absorbed from cloaca of five hens. *B*, amounts of I^{131} in isotonic solution absorbed from cloaca of five hens. Note large amount of residual isotope recovered from cloaca of second hen. *C*, amounts of I^{131} in hypertonic solution absorbed from cloaca of five hens. *D*, amounts of Na^{24} in isotonic solution absorbed from cloaca of five hens. Note large amounts of residual isotope recovered from cloaca of two hens.

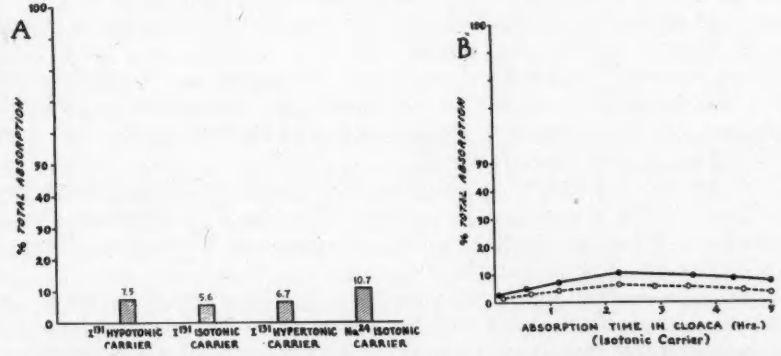

FIG. 2. *A*, comparison of mean absorption of four isotope solutions from cloaca. *B*, comparative rates of absorption of I^{131} and Na^{24} from cloaca of fowl. —●—●—● Na^{24}; —○—○—○— I^{131}.

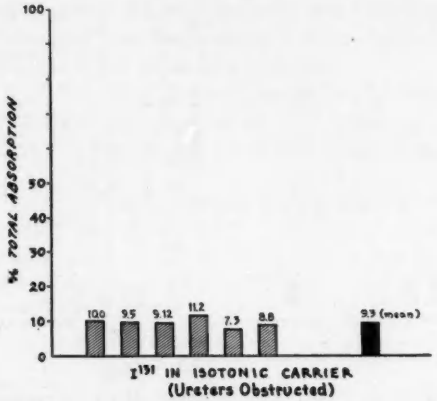

FIG. 3. Amount of I^{131} in isotonic solution absorbed from cloaca of six hens with ureters completely obstructed.

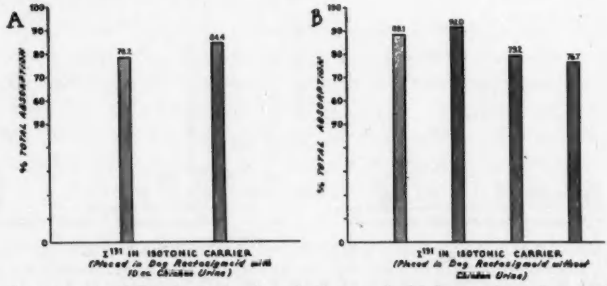

FIG. 4. *A*, amount of I^{131} in isotonic solution and chicken urine absorbed from rectosigmoid of two dogs. *B*, amount of I^{131} in isotonic solution absorbed from rectosigmoid of four dogs.

parently complete. The rate of absorption of chlorine and iodine in the two isotonic groups is shown in figure 2, *B*. It will be noted that the curve of absorption of these two electrolytes is similar.

Series 2. A second series of experiments was performed to rule out the possibility that following absorption the hen rapidly excretes electrolytes back into the cloaca. Such a phenomenon would mask greater absorption rates than those indicated by the previous experiments.

In six hens both ureters were ligated and divided to prevent urine from entering the cloaca during the absorption studies. Following this procedure cloacal absorption of I^{131} in isotonic NaI carrier was determined, as in series 1. Figure 3 shows the results in these animals.

Series 3. In contrast to the low absorptive capacity of the cloaca shown in these studies, previous experiments have shown that almost all sodium and iodine are absorbed from the rectosigmoid of dogs. Rosenberg[8] demonstrated this

[8] Rosenberg, M. L.: The physiology of hyperchloremic acidosis following uretero-sigmoidostomy: A study of urinary reabsorption with radio-active isotopes. J. Urol., **70:** 569–580, 1953.

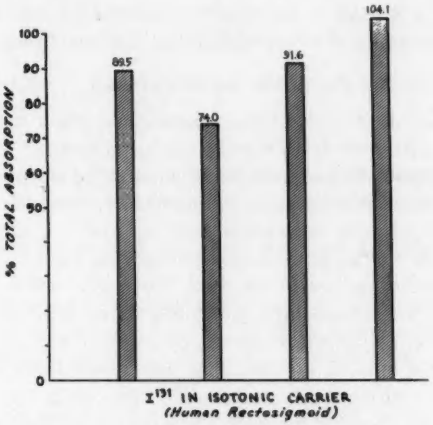

FIG. 5. Amount of I^{131} in isotonic solution absorbed from rectosigmoid of four human subjects.

in animals both with normal electrolyte balance and with hyperchloremic acidosis. Maximal blood levels of tagged electrolytes were attained three to four hours after rectal instillation. Thereafter less than 10 per cent could be recovered from the stool. In order to correlate this work under similar experimental conditions, we made additional studies in dogs. In two dogs, chicken urine was added to an electrolyte solution placed in the rectosigmoid. This was done to ascertain whether bird's urine might contain a substance which inhibits electrolyte absorption. In these animals weighing 7.8 and 8.4 kg., one millicurie of I^{131} in 100 ml. of isotonic NaI was mixed with 8.5 ml. of chicken urine obtained by ureteral catheterization and placed into the rectosigmoid. The anal orifice was occluded by suture, and urine and blood specimens collected at intervals of 15 minutes for four hours. Figure 4, *A* shows the high amounts of iodine absorbed.

Series 4. In an additional four dogs (weighing 7.3, 5.4, 6.4, and 6.3 kg.) the experiment performed in series 3 was repeated without the addition of chicken urine to the test solution. The total absorption of the rectally placed isotope is shown in figure 4, *B*. It is not significantly different from that in the animals in which chicken urine was added.

Series 5. Finally, for purposes of comparison determinations were made of electrolyte absorption from the rectosigmoid of four human subjects. One hour after a cleansing saline enema, 100 ml. of isotonic NaI containing 300 to 358 microcuries of I^{131} was instilled 12 cm. from the anal orifice as a retention solution. Urine and blood were collected every 30 minutes for four hours. At the conclusion of the study, radioactivity of the thyroid and rectosigmoid regions was measured. Figure 5 indicates almost complete total absorption of iodine in the four patients.

By measuring over the rectosigmoid with the scintillation counter in the first two patients, amounts of radiation above the levels elsewhere in the body (except over the thyroid) were found to be negligible. In the remaining two

patients, examination of feces obtained by enema showed less than 2 per cent and 3 per cent of the isotope in the rectosigmoid at the conclusion of the study.

ANCILLARY OBSERVATIONS

In addition to studies of electrolyte reabsorption, other factors which might prevent reabsorptive acidosis in the fowl were investigated.

Rate of cloacal emptying. Hens remain erect whether awake or asleep, and empty their cloacas four or five times an hour, night and day. Since our experiments were conducted with fluid retained in the cloaca for up to five hours, frequent cloacal emptying is obviously not a factor in preventing reabsorptive acidosis.

Cloacal reflux-resisting factors in the fowl. To study reflux 40 ml. of a thin barium mixture was introduced into the cloaca of six hens and the anal orifice sealed with a purse-string suture. Fluoroscopy revealed the presence of mucosal folds at the intestinal-cloacal junction (fig. 6). These folds, called Houston's valves, demonstrated 95 per cent competency even when the cloaca was over-distended at 40 cm. of pressure, far above normal cloacal pressures.

In all the electrolyte experiments in chickens, examination of the mucosa for staining with indigo carmine showed that the test solution never reached higher

FIG. 6. Valves at intestinal-cloacal junction in hen which prevent reflux. Demonstrated by barium enema at 40 cm. pressure.

	VOLUME IN BOWEL	SURFACE AREA EXPOSED	% ISOTOPE ABSORBED (4 hrs.)
MAN	100 cc.	600 cm^2 (±10%)	89.8 (Mean)
FOWL	10 cc.	60 cm^2 (±10%)	7.6 (Mean)

FIG. 7. Absorption of isotopes related to surface area exposed (mean of all experiments)

than 10 cm. above the anus and that there was no reflux either into the oviduct or ureters.

Surface area exposed. In attempting to correlate the quantity of electrolyte absorbed in man and the fowl in relation to bowel surface exposed, the comparisons shown in figure 7 were made. The isotopes represent the mean of all experiments.

The bowel area exposed to the electrolyte solution in man was estimated by placing the same quantity of thin colloidal barium rectally and observing on x-rays the distance this mixture diffused over a period of four hours. Although the spread is not identical to that of isotope-labelled solution, this distance and estimates of bowel diameter were used to obtain a rough estimate of the area of bowel surface exposed.

The calculations indicate that the volume of isotope solution (100 ml.) instilled in man exposed approximately comparable mucosal areas as the smaller amount (10 ml.) instilled in the fowl.

Apparently factors other than surface area account for the resistance of the mucosa of the cloaca which keeps absorption at such low levels. In discussing the problem of reabsorptive acidosis in man after ureterointestinal anastomosis Creevy,[9] Boyce,[10] and others[11, 12] have emphasized the need for transplanting the ureters to the distal part of the colon. Although there is reflux regardless of site this facilitates frequent bowel evacuation, decreasing the time urine is in contact with the bowel mucosa.

Early investigators of poultry physiology believed that the cloaca reabsorbed considerable amounts of water from the urine.[13] The results of more recent and comprehensive experiments indicate, however, that while some water is reabsorbed it is in insignificant amounts.[14]

[9] Creevy, C. D.: Some observations upon absorption after ureterosigmoidostomy. J. Urol., **70:** 196–202, 1953.

[10] Boyce, W. H.: The absorption of certain constituents of urine from the large bowel of the experimental animal. J. Urol., **65:** 241–261, 1951.

[11] Ferris, D. O. and Odel, H. M.: Electrolyte pattern of the blood after bilateral ureterosigmoidostomy. J.A.M.A., **142:** 634–641, 1950.

[12] Jewett, H. J.: Uretero-intestinal anastomosis in two stages for cancer of the bladder: modification of original technique and report of thirty-three cases. J. Urol., **52:** 536–562, 1944.

[13] Hester, H. R., Essex, H. E. and Mann, F. C.: Secretion of urine in the chicken. Am. J. Physiol., **128:** 592–602, 1940.

[14] Hart, W. M. and Essex, H. E.: Water metabolism of the chicken with special reference to the role of the cloaca. Am. J. Physiol., **136:** 657–668, 1942.

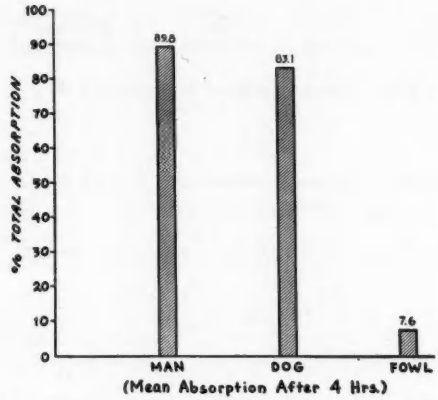

FIG. 8. Comparison of isotope absorption in man, dog, and fowl

SUMMARY AND CONCLUSIONS

It has been interesting to verify the assumption that urine is contained in the cloaca without disturbance of electrolyte balance. Apparently the problem is a simple one. The cloaca, with histologic resemblance to the large intestine, has more nearly the physiologic characteristics of a urinary bladder (fig. 8). In contrast to the rectosigmoid which absorbs almost all sodium and iodine the cloaca absorbs hardly any.

To eliminate the possibility that frequent emptying would minimize absorption from the cloaca, the anus was sealed during our experiments—carried out for a sufficient period of time for equilibrium to be reached between the fluids of the cloaca, the circulating blood, and tissue spaces.

Apparently the urine of the bird contains no constituent, such as an enzyme, which prevents its absorption. Addition of bird's urine to solutions placed in the rectosigmoid of dogs exerted no deterrent effect upon its absorption. Nor did varying the concentration of the instilled solutions exert any discernible effect.

Finally, the area of exposed mucous membrane is no significant factor. Comparison shows that the relationships of the surface area to the fluid content parallel each other in the rectosigmoid and the cloaca.

We are left only with the remarkable physiochemical adaptation of the cloacal wall to explain the bird's protection against reabsorptive acidosis.

There is no obvious clinical application we can make of this knowledge. However, in humans there may be some degree of individual adaptation following diversion of the urine to the rectosigmoid. It has seemed to us that children who have undergone ureterosigmoidostomy appear to be more adaptable to the formation of a cloaca than do adults. There have been fewer electrolyte disturbances and when they do occur they seem more transient in the child than in the adult. Whether this represents only a renal compensatory mechanism, or whether there are also compensatory changes in the colon which affect its absorptive capacity is

still unknown. It is possible that the lesser incidence of pyelonephritis and hydronephrosis in the child may be reflected in a better electrolyte balance.

We are making comparative studies following ureterosigmoidal anastomosis in the child and adult to determine whether there is any difference in the rate of absorption of tagged electrolytes.

While it has been illuminating to investigate the cloaca as far up as Houston's valves, we are intrigued with speculations as to what would happen if the ureters of the fowl were re-implanted in the upper intestinal tract. In studies performed in 1940 we found that re-implantation of the ureters into the cloaca was frequently attended by the development of upper urinary obstruction and ascending infection, indicating that the fowl is not immune to these complications of the human.[1]

It would seem reasonable that under suitable conditions the fowl will also develop hyperchloremic acidosis.

The authors express their appreciation to Drs. Milton L. Rosenberg, Robert R. Newell, and Arjan D. Amar for assistance in the conduct of this study.

ILEOCYSTOPLASTY FOR BLADDER ENLARGEMENT

LOUIS M. ORR, MILES W. THOMLEY AND JAMES L. CAMPBELL

A 63-year-old white man first consulted an urologist elsewhere in March 1948, complaining of frequency and urgency of urination of about six years' duration with marked exacerbation a few days before examination. On the initial examination the prostate was said to be somewhat enlarged and was considered benign. He was placed on catheter drainage and received penicillin. Subsequent cystoscopy six days later revealed an acutely inflamed mucosa with moderate intraurethral protrusion of the lateral lobes of the prostate. The bladder was said to be markedly contracted; the true capacity, however, was unknown. Eight days later the patient stated that tubercle bacilli were found in his urine. A transurethral prostatic resection was later performed. The removed prostatic tissue was reported as negative for evidence of tuberculous involvement. For the next three years the patient had intermittent return of symptoms and was treated with streptomycin, chloromycetin and sulamyd at different times with some relief, but upon cessation of therapy his symptoms returned. The bladder capacity on June 15, 1951 was said to be 7½ ounces and at this time he was free of pain and subjective symptoms.

The patient came under our observation in June 1956. He was complaining of marked frequency, burning and great urgency of urination, both day and night, and a feeling of weight in the suprapubic region, especially when lying down. With this present attack of frequency there was considerable nausea for the first time since 1951. He stated that he underwent a left nephrectomy in 1915 for a football injury in 1913. An intravenous urogram revealed a normal right upper tract and a small bladder. Cystoscopy under local anesthesia revealed an extremely sensitive bladder with a residual of 1 ounce and a preliminary diagnosis of interstitial cystitis was made. The prostate was of normal size and consistency and felt benign on rectal examination.

On July 8, 1956 the patient was admitted to the hospital where investigation revealed essentially normal urine with an occasional white blood cell, normal blood studies and a roentgenogram of the chest revealed calcifications in the right apex which were interpreted as healed tuberculosis. On July 9, 1956 a cystoscopy under spinal anesthesia revealed the bladder mucosa to be typical of interstitial cystitis. The bladder could not be dilated to contain more than 100 cc fluid. Two small nonretention diverticula were noted in the posterolateral aspect of the bladder. The lateral prostatic lobes were slightly enlarged. A culture of the urine from the bladder and right kidney was positive for Pseudomonas aeruginosa, which was found to be sensitive to polymyxin. No acid fast organisms could be demonstrated.

The decision was made to attempt to relieve the patient's very severe urinary distress by enlarging the bladder capacity by ileocystoplasty. On July 23, 1956 the abdomen was opened through a right lower paramedian incision. A segment of terminal ileum measuring approximately 18 cm. in length was isolated,

divided from the remaining bowel, as was the attached mesentery down to the base, and then closed with a Parker-Kerr stitch reinforced with interrupted No. 4-0 silk sutures. The small bowel was then reanastomosed with a two layer closed anastomosis. The bladder was then identified and found to present a very small surface. The peritoneum over the midportion of the bladder was sutured to the posterior wall of the isolated segment. A two layer continuous anastomosis was then made between the bladder wall and the segment of ileum on its antimesenteric border. The opening between the bladder and ileum was made approximately 4 cm. in length. The defect in the mesentery left by the removed segment was closed to prevent herniation. The lower abdomen was drained through a stab wound. A No. 22 Foley catheter was placed in the bladder.

His postoperative course was generally very satisfactory. There was minimal drainage from the wound and on the seventh day all sutures and the drain were removed. On the sixteenth day the urethral catheter was removed and by the nineteenth day the patient was voiding comfortably and without difficulty, retaining urine up to two hours.

On his first postoperative visit to the office he reported the interval between voiding to be as long as five hours with nocturia of two to three times. The residual was 2 ounces.

On September 10, 1956 a cystogram revealed a saccular type defect filled with contrast medium above the bladder and extending toward the right. On September 24, 1956 he was again seen and at that time the urine contained 10–15 white blood cells, the patient had no complaints and a No. 24 sound passed with ease and the residual bladder urine was 2½ ounces. On December 3, 1956 he had nocturia one time and a residual of 3 ounces. On February 7, 1957 a cystogram revealed the ileal attachment to have increased in size and it appeared in the shape of a sausage. On March 27, 1957 the patient stated he voided only once at night, was extremely happy with the result. The cystogram (fig. 1, *A*) showed good filling of the bladder and partial filling of the ileal anastomosis. A

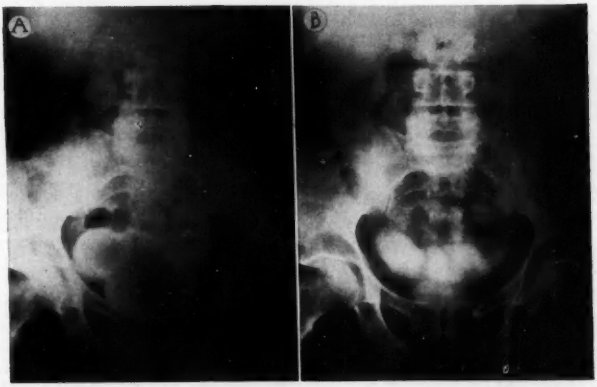

FIG. 1

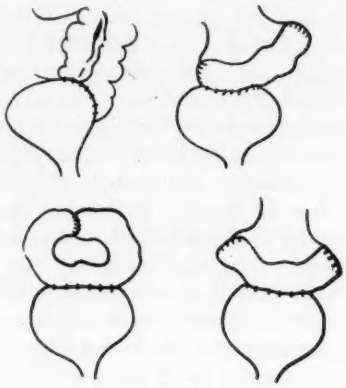

FIG. 2

voiding cystogram (fig. 1, *B*) showed retention of a considerable amount of the injected material and the residual urine was 6 ounces on April 1, 1957.

HISTORICAL NOTES

The first operation (ileocystoplasty) was performed by von Mikulicz in 1898. Shoemaker,[1] in 1909, with the idea in mind of putting a tuberculous bladder at rest, implanted the sole remaining ureter in a loop of ileum, the lower end of which was brought out through the abdominal wall. When the bladder was healed, the ileum was detached from the abdominal wall and anastomosed to the bladder. During the next twenty years numerous reports of cases appeared in the Spanish, French, Belgian and British literature, where some portion of the alimentary tract was joined to the bladder. Segments of the ileum, with one end closed or both ends closed, and segments of the colon and cecum were anastomosed to the bladder in various ways and fashions. Scheele, in 1941, anastomosed the center of an isolated loop of ileum to the bladder and then joined the ends of the loop together, producing what came to be known as a *ringplastik*.

Couvelaire, in 1950, was actually the first to advocate ileocystoplasty as a suitable procedure for enlarging the healed tuberculous bladder.

Jacobs[2] made a flat patch of the ileal segment by dividing the graft and then anastomosing one to the other (fig. 2). This flat patch was then anastomosed to the sagittally opened bladder, the idea being to maintain the enlarged bladder in the form of a sphere. Jacobs states that "the use of the terminal ileum to increase the capacity of contracted bladder is feasible and appears to be a reasonable procedure when conservative measures fail to improve capacity. The optimum technique, however, has not as yet been determined and the operation is not without its hazards."

[1] Shoemaker (1909), quoted by Hinman, F. and Weyrauch, H. M.: Trans. Amer. Asso. Genito-Urin. Surg., **29:** 15, 1936.

[2] Jacobs, Arthur: Ileocystoplasty. Glascow Med. J., **36:** 130–135, 1955.

Pyrah and Raper,[3] in 1955, carefully reviewed the literature, reciting three cases, and described the various surgical methods employed.

In Cibert's[4] article regarding anatomic and physiopathologic factors influencing technique and indications of ileocystoplasty, he mentions that the detrusor, instead of forming an extensible cupola above the trigone, has become a rigid ceiling. There the vesical cavity is composed almost entirely of the trigone. Instead of anastomosing the isolated ileal loop to a simple linear opening in the bladder dome, a preliminary resection of the remaining detrusor is performed, thereby avoiding the most diseased portion of the bladder in order to prevent retraction of the lumen of the anastomosis. Ileocystoplasty appears to reverse the threat of renal destruction due to increased intravesical and intraureteral pressure, by diverting the increased tension to the intestinal graft.

COMMENT

Ileocystoplasty is a surgical procedure of major proportions. The act of urination is likely to be somewhat abnormal during the first weeks after operation and interrupted voiding impulses are not unusual. A sensation of fullness in the lower abdomen may be present. Some surgeons claim that manual pressure above the pubes may assist in emptying the bladder.

What is actually accomplished by the operation is to produce an artificial diverticulum which allows for greater bladder capacity. This type of diverticulum does differ from the so-called acquired or true diverticulum in that the ileal loop addition does have modest contractile powers, possibly assisting in emptying the bladder. It also differs in that it has a wide stoma into the bladder, which makes for better emptying of the sac. The fact remains, however, that the addition of the diverticulum does mean the creation of residual urine, of greater or lesser degree, the consequences of which would appear to be no different from a residuum created by any other means. In the patient here discussed the residual urine has been increasing since the time of operation from two to seven ounces, and it is quite possible that the residuum may in time increase due to the positive pressure exerted by the filled bladder upon the walls of the loop. Little mention is made of this sequella in the literature.

Consideration must also be given to the quality of the urine after ileocystoplasty as mucus, secreted by the loop mucosa, may occur in such degree as to cause annoyance. Such has not been a problem in our patient.

It has recently been shown in animal experimentation by Shoemaker[5] and his group that if the mucosa is removed from the ileal loop the problem of mucus in the urine will be eliminated. The use of a seromuscular ileal graft to the bladder of animals, as described by Shoemaker, may stimulate its use in the human. As to how much such a graft can increase the size of the small contracted bladder

[3] Pyrah, L. N. and Raper, F. P.: Some uses of an isolated loop of ileum in genito-urinary surgery., Brit. J. Surg., **42:** 337, 1955.

[4] Cibert, J., Durand, L., Foret, J. R., and Solar, A.: Small bladder in urinary tuberculosis: Anatomic and physiopathologic factors influencing technic and indications of ileocystoplasty. J. d'urol., **60:** 125, 1954.

[5] Grotzinger, P. J., Shoemaker, W. C., Ulin, A. W., Marucci, H. D. and Martin, W. L.: The use of inverted seromuscular grafts from the ileum and colon for reconstruction of the urinary bladder. Ann. Surg., **140:** 832–838, 1954.

is debatable, as the posterior surface of such a bladder offers not too great an area for a large sized patch considering that it is much more hazardous to anastomose a single layer of the ileum to the bladder wall than the two layers as is the case with the ileal loop. Failure of the anastomosis will result in leakage of urine and possible fatality to the patient.

Ileocystoplasty is a procedure which offers great possibilities for the relief of the suffering associated with a contracted bladder, where all other conservative procedures have failed.

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DISCUSSION

DR. FRANK C. HAMM (Brooklyn, New York): I would like to discuss Dr. Orr's paper on ileocystoplasty. Two main types of anastomoses have been advocated for ileocystoplasty. In one a straight tube of ileum is used to augment bladder capacity and in the other the ileum is incised and sutured as a patch to the bladder. I would like to mention briefly the experimental work done by Drs. Weinberg and Sinatra in our laboratory at the University of the State of New York. Drs. Weinberg and Sinatra used the patch. Before the ileocystoplasty a subtotal cystectomy was done in which almost the entire bladder was removed. Dr. Weinberg got as close as he could to the trigone and anastomosed a patch of ileum around the small stump of bladder.

The ileal segment was opened wide and the patch was made with the mucosa intact. As a first step the posterior layer of the patch is sutured to the bladder stump by a mucosa-to-mucosa technique with chromic catgut and then a second layer of interrupted Lembert sutures are used. Finally, the peritoneum is sutured to a vascular pedicle of the transplant in an attempt to prevent internal hernia. A urethral catheter is kept in the bladder for eight days in the female and in the males a cystotomy tube is used for seven days and then withdrawn.

In this work eight dogs were used. One dog died of perforation by a catheter while a postoperative cystometrogram was being done. Apparently these bladders are easy to perforate. Another dog died two weeks after the operation. We don't know exactly what the cause was; the bladder seemed to be healing well. All others lived.

It was felt that the patch type of anastomosis will be least likely to result in a diverticulum effect whereas the tube type of anastomosis does result in a diverticulum. It has been shown that the ileal tube is filled primarily and then the bladder. Voiding with this type of bladder after ileocystoplasty takes place in two stages. First the bladder empties and then the ileal tube. The patch type of repaired bladder has a more efficient physiology.

Urograms were done on all the animals and showed normal upper urinary tract. All of these dogs appeared healthy. They all seemed to void normally.

It is impossible for us to determine residual urine in dogs. Blood chemistries and electrolyte determinations were done. The values in the dogs after the operation are slightly over normal values but apparently not enough to interfere with the health of the animals.

In the first few weeks there was a fair amount of mucus but it seemed to diminish as time went on. The oldest dog is a little over six months postoperatively now. Microscopic studies show that after several months there is considerable change from the normal appearance of the dog's ileum and fewer mucus secreting glands are present and the plica tend to disappear.

Autopsy specimens of the bladder after ileocystoplasty tend to assume a normal appearance. There is no evidence of diverticulum and we have not noticed that residual urine or bladder capacity tends to increase, as described by Dr. Orr, as time goes on. Although we haven't observed this long enough, Dr. Wein-

berg has a female patient who has been followed over a year and a diverticulum-like appearance has not developed in the transplant. Studies of the kidneys in some of the animals showed little or no pyelonephritis.

We have two female patients who were done within the last three months. The immediate postoperative course has been satisfactory. Of course, it is much too early to make any long-range prognosis.

Dr. John K. Lattimer (New York, N. Y.): We have been using the "patch" technique for enlarging tuberculous bladders at the Research Unit for Genito-Urinary Tuberculosis, and I can show you some slides on the technique. We isolate a 5-inch segment of ileum. These are tuberculous bladders, quite shrunken, thickened, and a bit difficult to find. We isolate a relatively short segment. We open up the shrunken bladder. We slit open the segment along its antemesenteric border. We open it up as a patch and fit it into the defect, trying to match the sizes as they lie.

We sew the patch into the bladder dome. Sometimes it is quite difficult to reach down on the underside and make a decent anastomosis. We have sewed the patch in with a single layer of atraumatic catgut. We have put in a cystostomy tube and a urethral catheter as well.

Before operation one bladder contained only 40 cc of fluid.

Seven months later the bladder had gradually increased in size up to a capacity of 300 cc and has stayed that way for about a year.

This man's urine has become progressively clearer. The cloud of mucus has not entirely disappeared in a year's time. However, he does not complain of any symptoms. His urinary function is perfectly satisfactory; he has no residual urine. We favor this particular technique if the bladder is only partly contracted.

The use of ileum to replace damaged ureters works well, provided the tuberculous disease has been controlled by prolonged chemotherapy first.

Mr. E. W. Riches (London, England): First, in reply to what Dr. Lopez has just said, it would be extremely nice if we knew beforehand whether the vein was involved. We haven't made the venograms. We have made the aortograms. Nor do we know beforehand the histological grade of the tumor. If we knew those things, I am sure we should use more preoperative therapy. Without knowing them, I am sure we shouldn't use preoperative therapy much more than we do. It has the disadvantages that he has just pointed out, but the cases I quoted were all done more than five years ago and we were using the ordinary 200 kilovolt x-ray therapy.

I have found it difficult, perhaps, to restrain the radiotherapy boys from giving all they have. I have stipulated that they give a dose of 3000 r within three weeks and let me do a nephrectomy within two weeks, and there haven't been the difficulties he has pointed out.

I have had difficulties in gross edema, certainly, in bad cases. One has to limit the amount. We have only recently used the betatron, the cobalt unit, and the unit accelerator. It is being used mainly for bladder tumors, but we are starting to use it for kidney tumors. You only have to see the results of any tumor treated on those machines which are the equivalent of three or four thousand

kilovolts to see that you can be left with a skin that is hardly pigmented. I am sure if we have the opportunity to use that on kidney tumors, we shall use it more extensively, and I don't think we shall encounter the difficulties that Dr. Lopez has pointed out.

Coming back to Dr. Flocks' paper, it covers a very much larger series of cases. I just picked out my personal cases. We did report more than 2000 cases at the British meeting some five years ago. He mentioned the grading and the difficulty in getting the pathologists to agree. I have been fortunate in having all my grading done by one pathologist.

I deliberately showed you those microslides of the grading to show the sort of things they go by. They will take a big section and expect to find different types of tumor throughout that section, and they will grade by the worst part, just as the one bad link in a chain will destroy the whole thing. So, they take one grade 3 area of the kidney tumor and must call the whole thing grade 3.

I was sorry to hear that Dr. Flocks had given up using preoperative x-ray treatment since 1940. He said there was insufficiency in diagnosis, and they radiated some cysts. I feel this is one of the conditions in which an aortogram is certainly justified.

Speaking over in San Francisco recently, I found considerable temerity over here in the use of aortography. I was asked what the legal implication is. I feel they are just those of any other preoperative investigation. You may get into trouble after doing a pyleogram. There is hardly any investigation that doesn't give rise to some trouble some time. Certainly, in our first 300 cases—touching wood—we had no real serious complications. It may be with the recent developments of aortography that we will, perhaps, have to adopt that method as being freer from the serious complications like dissecting aneurysms or injury to spinal arteries, which certainly have been reported.

Dr. Flocks mentioned the life history of these tumors. Well, it is a very important point, and it was illustrated with one patient of ours, an old woman, who came in with hematuria, and whose x-rays showed she had a hypernephroma. We let her go. She came back seven years later with repeated hematuria. She became anemic and had hypertension, and we took her kidney out. She died in a few days. Her kidney had a growth. Either it was because it was a low grade, or because she had some peculiar resistance to malignant disease—she had been harboring it for seven years.

Even the untreated cases had a 3 per cent survival. I didn't include any Wilms tumors. I didn't include any pelvic tumors. It seemed to me they are in quite a different category. I will say this about the Wilms tumors, that I adopt exactly the same treatment as Dr. Flocks does. I take out the tumor, and then give as early as possible postoperative x-ray treatment. I have had some preoperatively and find only too often that the child is in no fit stage to stand an operation. I have had them killed by preoperative therapy. Although it will reduce the size of the tumor and make the operation easier as a routine, we don't use preoperative therapy for Wilms tumor, but do get it into them postoperatively as soon as we can.

The only long-term survivors reported in the British Isles had had no x-ray therapy either before or after operation. Of my own knowledge, there was only one long-term survivor, and that was a girl whom I did when she was two and a half. I took her kidney out. There was no x-ray therapy. She is now 24, very well, and has two children.

Thus, I am just a little bit doubtful of x-ray therapy of Wilms tumor, although we use it.

DR. RUBIN FLOCKS (Iowa City, Iowa): I enjoyed this whole morning, and particularly, did I enjoy Mr. Riches' discussion of renal tumors. To me, the striking thing of our own analysis, which I did not expect, was the fact that combined therapy may be of value, and that the whole program with regard to the management of these tumors as far as we are concerned will need to be re-evaluated and the possibilities of combined therapy investigated further, particularly with the advent of much better types of radiation techniques.

Another thing I am going to do as a result of Dr. Riches' paper is get out the pathological slides. Of course, they may not be representative, but we have the slides on all these patients, and we will get them out, the 10-year survival patients, and see what the pathologist says with regard to their relative grade.

With regard to Dr. Lopez's questions, even with the aortography, we have missed the diagnosis between known neoplastic masses and cystic masses involved in the kidney. Just how to solve that particular problem, I don't know. We will have to give it a lot more thought.

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The technique that was used in these cases was the 250 kilovolt machine with an attempt to get between 5000 and 7000 roentgens into the tumor. Then we operated upon them about three weeks after the completion of the x-ray therapy. At that time, we found that there were no adhesions, that, actually, it was much easier to get around the tumor mass than it would have been, or certainly just as easy as it would have been without deep x-ray therapy. In a few instances, the patient did not return for an operation at the prescribed time and was operated on much later. In those instances, there was a tremendous amount of scarring and the operative procedure was much more difficult.

DR. LOUIS M. ORR (Orlando, Fla.): I appreciate very much the discussions which this simple little operation that we performed seemed to stimulate. I am glad Frank Hamm showed his slides of what he is doing in dogs.

Putting a patch on the dog is quite different from putting a patch on a human with a very small, contracted bladder. I think that the patch method will shortly be superseded by the patch method described by Shoemaker in which he moves the mucosa and finds that the patch is covered by transitional epithelium.

Mucus is a polysaccharide. It increases proportionately toward the end of the alimentary tract. I would presume that the larger the ilea attachment, the more

the problem with mucus. For that reason, I don't think the procedure we have shown is the ideal thing to increase bladder capacity.

Now, on Dr. Lattimer's patients, I feel that one of the reasons he is getting increased bladder capacity is that he is really dissecting out the bladder. He is freeing up his perivesical tissues and allowing for more expansion of the bladder.

I am very sorry, and apologize to Mr. Hanley (London, England) but in going through the literature and the many translations of the Belgium and French and Japanese, I found that Arthur Jacobs was given credit in three instances. My apologies to you, sir.

In these patients with the loop attachment, the voiding impulse is greatly delayed. In this type of loop attachment, there is little or no impulse. We have tried this patient under different circumstances, such as pressing his bladder above the pubis, but he cannot generate enough impulse to empty it. Consequently, I think we are going to have a larger distension of the ileal loop and probably more mucus.

Dr. William Wallace Scott told me of an instance of ileocystoplasty. He has recently done this procedure on an officer in the service, and he finds now that his bladder, I believe, from interstitial cystitis has increased in capacity. It is very difficult to measure the bladder capacity—that is, the part of the capacity that has to do with the true bladder wall, after you put a graph on. He feels now he is going to be able to go back in and remove this ileal attachment, which will certainly be a great piece of work and a great help to the patient.

I want to say I enjoyed the discussions very much, and I have enjoyed the papers this morning very much indeed.

SOME METABOLIC ASPECTS OF URINARY CALCULI

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For two decades it has been good practice to look for primary hyperparathyroidism among patients with calcium urolithiasis or nephrocalcinosis. As predicted by Albright and associates, a diligent search for this condition is rewarding in about 5 per cent of cases, and continued screening of urologic patients for hyperparathyroidism has led through the years to recognition of other conditions associated with excessive urinary calcium which, like hyperparathyroidism, may provoke formation of urinary calculi or nephrocalcinosis on occasion. Some of these conditions may be lethal, of themselves, such as multiple myeloma, whereas others, while serious, are amenable to therapy, such as renal tubular acidosis. As is the case with hyperparathyroidism, recognition and treatment of such disorders occasionally provide the urologist with a useful opportunity of putting a halt to the stone-forming process. Unfortunately, only a minority of stone-formers fall in such categories, and the majority of stone-forming patients show no clear-cut abnormality of calcium metabolism of practical clinical significance even after exhaustive and expensive search. Nevertheless, the possibility of decisive aid is real enough to justify some metabolic evaluation of all patients who form stones, and exhaustive metabolic evaluation of many, particularly those with recurrent or multiple stones. Such an evaluation has as its first stage the recognition or exclusion of primary hyperparathyroidism; as its second, the differentiation of other hypercalcemias; and as its third, evaluation of renal hypercalciurias.

LABORATORY AIDS

All these diagnostic problems share a common difficulty; namely, complete dependence of the physician on the laboratory. Hyperparathyroidism could be defined in one view as hypercalcemia for which alternative explanations have been excluded. The other conditions to be discussed may also be discovered at times only through accurate evaluation of reliable laboratory data, rather than discriminating appraisal of clinical history and physical signs. It is appropriate therefore to discuss certain laboratory procedures briefly.

Serum calcium. Values cited in many texts for the normal range of serum calcium are usually 9 to 11 mg. per 100 ml. (or even 8 to 12). Such ranges are misleading and may reflect older methods; at any rate they are not sufficiently precise for present application. The mean value for serum calcium in 109 healthy adults in our laboratory was 9.77 mg. per 100 ml.* with a standard deviation of 0.31 mg. per 100 ml. The "normal range" including 95 per cent of the normal population so described is 9.2 to 10.4 mg. per 100 ml. The error of the method as indicated by replication is 0.01 mg. per 100 ml.

* By the method of Power, Toogood and Adamson, employing oxalate precipitation and permanganate titration.

Serum phosphorus. Serum inorganic phosphorus in 109 adults averaged 3.4 mg. per 100 ml.* and the "normal range" encompassing 95 per cent of an adult population was 2.5 to 4.3 mg. per 100 ml. It should be noted that a fourth of the normal population by this method have serum phosphorus values in the range 2.5 to 3.0 mg. per 100 ml., commonly accepted as below normal.

CONDITIONS IN WHICH CALCULI ARE FORMED

Calciuria. Urinary excretion of calcium must be evaluated with the patient on a diet in which the calcium intake is known and controlled. We have employed a quantitative diet containing 2,000 calories and 135 mg. of calcium per day (the "Bauer-Aub diet"), usually for 3 days at a time. Normal persons usually excrete less than 100 mg. of calcium per day on this program. Some healthy individuals may excrete up to 150 mg. per day, but values in excess of this figure may be regarded as abnormally elevated.

Primary hyperparathyroidism. Primary hyperparathyroidism must be distinguished from other conditions associated with hypercalcemia: hypervitaminosis D, multiple myeloma, Boeck's sarcoid, carcinomatosis ossei (and also carcinomatosis without obvious skeletal involvement in certain instances), acute osteoporosis of disuse, Paget's disease with immobilization, and the milk-alkali syndrome, all of which may produce renal calculi or nephrocalcinosis. Primary hyperparathyroidism shares with these conditions a group of symptoms associated with hypercalcemia per se. These are muscular weakness, fatigue, polyuria and polydipsia, and gastrointestinal symptoms such as constipation, anorexia, epigastric pain, and nausea and vomiting. The serum calcium must usually be *substantially* elevated (that is, more than 12 mg. per 100 ml.) before such symptoms are encountered.

If significant osseous disease is present, patients with hyperparathyroidism may have symptoms referable to the skeleton. These may include all manner of crippling deformities, pathologic fractures, cysts and tumors of bone, and the like. In less severe cases, skeletal symptoms may consist only of vague and ill-defined aches and pains. When such osseous symptoms are present, a competent roentgenographic examination should automatically lead to the correct diagnosis. Determination of alkaline phosphatase provides both a clue to the presence of bone disease and a measure of its severity but has nothing directly to do with parathyroid function. The level of alkaline phosphatase may, in fact, be quite normal if the skeleton is not grossly involved, even though severe hyperparathyroidism is present.

Hyperparathyroidism may produce symptoms referable to the urinary tract whenever kidney stones or nephrocalcinosis occurs. There is widespread belief that there is something pathognomonic or specific about the urinary manifestations of parathyroid disease, but, alas, such is not the case. Any and all of the signs and symptoms of kidney stones and their complications and all of the consequences of nephrocalcinosis may occur and, when they do occur,

* By modification of the method of Fiske, C. H., Subbarow, Y. and Gomori, G.: J. Lab. & Clin. Med., **27**: 955, 1942.

are indistinguishable from the urologic disturbances encountered in patients without parathyroid disease. The composition of the kidney stones is not helpful. Three fourths of the stones examined from cases of proved hyperparathyroidism are reported to consist predominantly of calcium oxalate; the remainder are calcium carbonate or calcium phosphate. Relatively few are branched stones.

Lastly, there is a growing number of patients proved to have hyperparathyroidism despite complete absence of symptoms referable either to urinary tract or skeleton. These patients with asymptomatic hyperparathyroidism have usually been found entirely by accident ("serendipity") or as a result of blindly seeking the condition at random in a large group of patients. The study of such individuals has led to the concept that hyperparathyroidism is a disease which in its milder forms produces no recognizable signs or symptoms until some complication occurs, such as osteitis fibrosa or nephrolithiasis. Prolonged followup of patients with such asymptomatic hyperparathyroidism justifies the conclusion that such complications, especially urolithiasis, are probably certain to occur sooner or later, although one such patient was followed for more than 10 years before urolithiasis developed for the first time.

Hypervitaminosis D. Hypervitaminosis D may sometimes closely simulate hyperparathyroidism clinically and chemically. The general impression that hypophosphatemia does not occur in this condition and, therefore, that the absence of hypophosphatemia differentiates hypervitaminosis D from primary hyperparathyroidism is, unfortunately, not always true. While osteitis fibrosa cystica is not seen, some skeletal demineralization and nephrocalcinosis sometimes occur, and calculi have rarely been seen. There is no convenient means of differentiating hypervitaminosis D from hyperparathyroidism other than by obtaining a history of ingestion of vitamin D in toxic amounts. In some cases treatment with cortisone, or with a diet low in calcium with copious fluids may ameliorate or correct the hypercalcemia in a few days, but in others, the abnormal calcium metabolism may be for a time as refractory to such treatment as is hyperparathyroidism. Theoretically, demonstration of decreased fecal excretion of calcium by metabolic balance techniques might prove diagnostically useful, but this is not a clinically practical method.

Sarcoidosis. This may prove difficult to differentiate from primary hyperparathyroidism. Early studies were interpreted as showing that hypercalcemia occurred in this condition, as well as in myeloma, only in association with hyperproteinemia. On the contrary, it is now clear that hypercalcemia disproportionate to hyperproteinemia, or even without hyperproteinemia, occurs fairly often in sarcoidosis. Serum phosphorus may be reduced at times and this, in association with renal lithiasis or nephrocalcinosis, may in some instances make sarcoid exceedingly difficult to differentiate from primary hyperparathyroidism. The finding of an elevated sedimentation rate should initiate further study, while lymphadenopathy or cutaneous or pulmonary disease has on occasion provided diagnostic information decisive enough to avoid unnecessary exploration for parathyroid disease.

The disturbance of calcium metabolism producing hypercalcemia and its

consequences in sarcoid disease appears to be the result of an endogenous hypervitaminosis D and, like exogenous hypervitaminosis D, may occasionally be differentiated from hyperparathyroidism by a therapeutic trial of adrenal steroids or of a diet low in calcium with copious fluids. There is uncertainty whether the lesion of sarcoidosis produces a substance physiologically similar to vitamin D or one which potentiates the action of vitamin D and thus sensitizes the patient to normal quantities of vitamin D. Whichever is the case, the essential metabolic changes in this disease are analogous to those of hypervitaminosis D, namely, increased gastrointestinal absorption and reduced fecal excretion of dietary calcium.

Multiple myeloma. Like sarcoidosis, this may sometimes be characterized by hypercalcemia, hypophosphatemia, and hypercalciuria, as well as by skeletal lesions and urolithiasis. Whereas an elevated sedimentation rate, characteristic roentgenographic findings, and the demonstration of myeloma cells on sternal aspiration may differentiate the conditions, myeloma may sometimes simulate hyperfunctioning parathyroid disease closely indeed.

Carcinomatosis ossei. Extensive skeletal destruction by malignant cells sometimes results in precisely the same pattern of hypercalcemia described for sarcoid or myeloma. Some recent work would indicate that hypercalcemia may occasionally occur in association with disseminated carcinomatosis even though the skeleton is not demonstrably involved. The disturbance of calcium metabolism involved in such instances may prove analogous to that described in sarcoid.

Acute osteoporosis of disuse. Abrupt immobilization of healthy young adults, as by paralysis or serious injury, may produce an acute pattern of massive demineralization of the skeleton, hypercalcemia, hypercalciuria, renal insufficiency, and renal lithiasis. While the obvious cause generally precludes diagnostic confusion, it should be noted that the characteristic changes in the composition of blood and urine may be virtually indistinguishable from those occurring in the other hypercalcemic disorders described. An analogous situation following immobilization has been described in older persons with extensive polyostotic osteitis deformans (Paget's disease).

Milk-alkali syndrome. Renal insufficiency and hypercalcemia (sometimes with normal or even slightly lowered serum inorganic phosphorus) may result from excessive ingestion of milk and absorbable alkali, usually taken as treatment for peptic ulcer. The resulting symptoms of hypercalcemia, sometimes with involvement of the urinary tract as well as calcinosis elsewhere, have occasionally caused these patients to be suspected of primary hyperparathyroidism and, in more than one instance, to undergo surgical exploration for parathyroid disease. The differential diagnosis, however, is seldom difficult provided a history of gastrointestinal disease and excessive ingestion of milk and absorbable alkali is obtained. Hypercalciuria, as defined by the Bauer-Aub test, is absent. However, urinary concentration of calcium great enough to contribute to calculus formation may be presumed to occur during ingestion of milk and absorbable alkalies (often calcium salts) but does not persist when excess dietary calcium is withheld. In some instances hypercalciuria has been observed the first day of

study on a diet low in calcium. The diagnosis is further confirmed by demonstrating rapid fall of serum calcium when the patient is given copious fluids and fed a diet low in calcium for a few days. Some improvement of hypercalcemia may occasionally occur in similar circumstances in hypervitaminosis D or sarcoidosis but has not been encountered in the other conditions which have been enumerated.

In practice most of the foregoing conditions can be distinguished from one another without particular difficulty, despite the common denominator of hypercalcemia. In occasional instances, however, the differential diagnosis of the hypercalcemias may be extraordinarily difficult and may tax the skill, experience, and resources of the physician to the utmost. The same comments may be applied with equal force to the diagnosis of primary hyperparathyroidism per se. Ordinarily the diagnosis of this condition is easy: once the possibility has been thought of, and several blood determinations have been obtained, the characteristic changes therein supported by definite hypercalciuria are quite decisive. Once alternative explanations are excluded, the diagnosis is usually secure. Difficulties arise as one attempts to establish the diagnosis in milder cases or in patients with impaired renal function in whom the pathognomonic chemical criteria are likely to be equivocal. With progressive renal insufficiency the elevated serum calcium falls, while the serum inorganic phosphate rises proportionately to nitrogen retention.

Present experience indicates that the average level of serum calcium need be elevated only a fraction of a milligram above the normal range in some cases, and in perhaps a fourth of the cases one or more determinations may be within the normal range. In about a third of the cases the mean value of inorganic phosphate lies between 2.5 and 3.0 mg. per 100 ml., which, while within the range of normal as defined here, is "low" by ordinary standards. In a few instances the mean value of serum phosphorus has been more than 3.0 mg. per 100 ml. even though no evidence of renal impairment was present! Urinary excretion of calcium may likewise be equivocal in mild cases. In general, evaluation of serum calcium and phosphorus and of urinary calcium taken together carries more weight than does any one test alone, particularly when the average of several determinations is used. Accurate assessment of such trivial alterations of serum levels is possible only if the laboratory is extraordinarily reliable and the physician is thoroughly conversant with the standards and variations characteristic of the laboratory.

The need for diagnostic accuracy is accentuated by the considerable technical complexities of parathyroid surgery. The diagnostician must do more than tell his surgical colleague: "This patient may have parathyroid tumor; probe around a bit and see if you can find one." The exploration for parathyroid tumor is too formidably difficult for a negative exploration to be diagnostically decisive unless four normal glands can be found and identified. The surgeon, therefore, requires and deserves reasonable certainty that a hyperfunctioning lesion is present.

SPECIAL DIAGNOSTIC TESTS

The foregoing situation has led to the development of three new diagnostic maneuvers for the evaluation of equivocal hypercalcemias. These are the calcium-loading test, measurement of the tubular reabsorption of phosphate, and the phosphate deprivation test.

The calcium-loading test has been evaluated by Howard and associates. It consists of observing the effects on urine phosphorus excretion and serum phosphate of giving a large intravenous load of calcium. The patient is given an infusion of 15 to 25 mg. of calcium as calcium gluconate per kilogram of body weight over a period of 8 hours. The following morning, a normal person will show elevation of serum phosphorus (greater than 0.5 mg. per 100 ml.) and a reduction of urinary phosphate to one half or one third. A patient with hyperparathyroidism generally shows no increase of serum phosphorus and little or no decrease of urinary phosphate. In addition to elucidating borderline calcium values, the test is occasionally useful in separating other forms of hypercalcemia from those due to parathyroid disease. It is not infallible, and paradoxical results occasionally occur.

The tubular reabsorption of phosphate can be estimated in the course of the Bauer-Aub test or the calcium-loading test. The serum concentrations and urinary excretion of phosphate and creatinine are determined. The endogenous creatinine clearance is taken to be an index of glomerular filtration, and the difference between this and phosphate clearance is assumed to be phosphate reabsorbed. Normal persons usually will reabsorb 80 per cent or more of glomerular filtered phosphate, whereas patients with parathyroid disease usually show lower values, sometimes as low as 50 per cent. The test is not valid in patients with impaired renal function—a serious objection—but offers another means of sometimes differentiating other hypercalcemias from parathyroid disease where this proves difficult.

In the phosphate deprivation test the patient follows a diet which is poor in phosphorus and high in calcium for a week or longer. This procedure is said to intensify the pathognomonic sign of hyperparathyroidism if present (by depressing serum phosphate and increasing serum calcium) and to restore equivocal values to normal in those instances in which hyperparathyroidism is not present.

TREATMENT

Hypercalcemia. Hyperparathyroidism is almost invariably a curable, surgical disease providing its renal consequences have not reached an irreversible and ultimately fatal stage. Approximately 80 per cent of cases are due to adenoma. In 4 per cent there are multiple adenomas. An additional 4 per cent of cases are associated with multiple endocrine adenomatosis in which adenomatous hyperplasia of two or more parathyroids with hyperparathyroidism is associated with an analogous change in the islands of Langerhans and hyperinsulinism, and, in some cases, with pituitary adenomas. Nine per cent of cases are associated with hyperplasia of wasserhelle cells and hypertrophy affecting all four parathyroids,

while in a very few instances truly malignant tumors, generally adenocarcinomas, have been found.

The treatment of hypercalcemia other than hyperparathyroidism is quite varied. Myeloma and carcinomatosis are probably not directly amenable to treatment. The acute osteoporosis of disuse and the hypercalcemia that results from immobilization in cases with extensive Paget's disease can be combated successfully by mobilization of the patient. If no other course is available, this may be achieved by putting the patient on a rocking bed. The hypercalcemia of sarcoidosis, hypervitaminosis D, and the milk-alkali syndrome are best treated by a low-calcium diet and liberal fluids. This is usually rapidly effective in milk-alkali syndrome and occasionally so in hypervitaminosis D and sarcoidosis. The hypercalcemia in sarcoid and hypervitaminosis D may respond favorably to the exhibition of cortisone.

Hypercalciuria without hypercalcemia. Hypercalciuria may occur without hypercalcemia in milder instances of some of the conditions already enumerated, such as acute osteoporosis, hypervitaminosis D, and perhaps some cases of myeloma or carcinomatosis.

In 1939 Flocks noted that the majority of patients with hypercalciuria have normal serum calcium and do not have hyperparathyroidism. Most, if not all, of these patients probably have an intrinsic defect of renal tubular function. It is of practical value to distinguish at least two categories of such patients for purposes of treatment. The first of these includes patients who can be recognized as having what Albright called "tubular insufficiency without glomerular insufficiency." The condition is often termed "hyperchloremic acidosis" because of its most conspicuous chemical characteristics. Such a condition may be congenital but is probably sometimes acquired, as a residue of previous pyelonephritis. The patients show reduction of serum carbon dioxide-combining power, compensatory increase of serum chloride, an alkaline urine, usually hypercalciuria, and an associated propensity to nephrocalcinosis or renal lithiasis. Usually there is also reduced ability to form ammonia, reduced titrable acidity, and increased urinary phosphate. In more severe cases, the patient may also have hypokalemia, hypophosphatemia, muscular weakness, and osteomalacia, although, as with primary hyperparathyroidism, many of these features are sometimes lacking. Perhaps the most direct clue to the existence of the condition is the coexistence of metabolic acidosis (reduced carbon dioxide-combining power) and an alkaline urine in patients without nitrogen retention. When this combination is associated with hypercalciuria, therapy with soluble alkali is usually in order. Providing there is no azotemia, treatment with 100 to 150 mEq. of sodium bicarbonate per day (supplemented by potassium salts if hypokalemia is present) may often produce a striking response. The hypercalciuria, hyperchloremia, hypokalemia, and acidosis may be quickly corrected, and in addition, there is usually improved strength and sense of well-being.

Why do patients with tubular acidosis respond in this unusual manner? It is generally considered that their intrinsic renal tubular defect makes it impossible for them to conserve base. As a consequence they waste sodium, potassium, and

calcium and, for some reason, relatively more calcium than other cations; hence hypercalciuria results. Liberal administration of sodium and in some instances potassium also permits the kidneys to spare calcium and to excrete preferentially the soluble cations.

When one considers this condition in the presence of borderline laboratory findings it may be difficult to be sure where physiologic variations leave off and significant hyperchloremic acidosis begins. Accordingly alkali therapy is often tried in patients with equivocal changes in serum chlorides and carbon dioxide-combining power and an unproved diagnosis (some of whom will have the disease and some will not). If a significant tubular defect is present the patient will usually show a striking clinical response and tolerate bicarbonate very well, whereas another patient with equivocal chemical data, but without tubular insufficiency, will seldom tolerate bicarbonate in the dose prescribed more than a week or two and will not show decisive response in blood levels. A therapeutic trial, therefore, has some diagnostic significance in borderline cases.

Several other varieties of tubular insufficiency have been described, each with characteristic physiologic defects, including amino-aciduria, glycosuria, and other changes. While all of them show excessive urinary excretion of phosphorus ("phosphate diabetes") and a tendency toward osteomalacia, most differ from the syndrome here discussed in not producing hypercalciuria or urolithiasis, although there are several varieties such as the Fanconi syndrome and related conditions which may do so.

Idiopathic hypercalciuria. There remain a large number of patients with hypercalciuria who are found to have normal serum calcium and no disturbance of serum chlorides or bicarbonate. In some of these patients hypophosphatemia is also observed. For want of a better term, such cases are categorized as "idiopathic hypercalciuria," a category probably comprising more than one pathologic entity. The etiologic and therapeutic significance of idiopathic hypercalciuria was emphasized many years ago by Flocks: it may cause kidney stones just as surely as hyperparathyroidism and, unfortunately, is sometimes more difficult to treat. It is in this group of cases particularly that various metabolic maneuvers are currently being evaluated, such as administration of phytate and aluminum gels. Aluminum carbonate therapy ("the Shorr regimen") is difficult and hence is usually restricted to patients with much at stake and sufficient motivation for a rigorous program. It consists of an attempt to reduce ingestion of phosphorus to a point at which urinary phosphate is as low as possible, thus facilitating solubility of calcium salts in the urine. In addition to a very Spartan diet low in phosphorus, the patient is given large doses of aluminum carbonate following meals. This material combines with dietary phosphate to form aluminum phosphate, which is excreted unabsorbed in the feces. Fortunately, it appears that relatively few patients actually need to follow the Shorr regimen and fewer still are willing to do so for prolonged periods; in those who do, results are often gratifying. A diet low in phosphorus should theoretically eventually result in osteomalacia, and we have encountered this in one instance.

There is currently much interest in the use of phytate (sodium inositol hexa-

phosphate) for the treatment of hypercalcemia and hypercalciuria of various types. This material prevents absorption of dietary calcium from the bowel in a manner analogous to that by which aluminum carbonate prevents absorption of phosphate; that is, it permits formation of insoluble calcium salts. Phytate therapy is thus a means of severely curtailing dietary calcium. While it will almost completely eliminate calcium absorption and thus greatly reduce calciuria, it unfortunately increases phosphorus absorption and, consequently, phosphaturia for the reason that phytate is composed largely of phosphorus. The net effect on the urinary solubility of calcium may, therefore, possibly not always be to the patient's advantage.

A METABOLIC SURVEY

From the foregoing considerations, it is possible to evolve a working program for evaluating metabolic factors in patients with kidney stones or nephrocalcinosis. How thoroughly such a program should be pursued in an individual case must at times be determined in part by consideration of how much the patient has at stake. A patient who has a single stone and two good kidneys may, of course, never have another episode. We believe that even such patients should be investigated at least to the extent of excluding primary hyperparathyroidism, but the physician may not always feel justified in involving such a patient in a more time-consuming and expensive program. However, the patient with repeated renal colics, multiple stones, repeated renal surgery, or damaged kidneys should be, and usually is, willing and deserving of every therapeutic and diagnostic aid available.

Thorough study usually involves several estimations of serum calcium and phosphorus and an estimation of alkaline phosphatase to evaluate the need for a skeletal survey. Quantitative evaluation of calciuria is usually important. Special tests, such as the calcium-loading test, calculation of phosphate reabsorption, and the like, are usually reserved for the difficult diagnostic problems. Ruling out various sources of hypercalcemia, once this is demonstrated, can involve a very comprehensive examination. In the absence of hypercalcemia or azotemia, estimation of serum electrolytes (sodium, potassium, carbon dioxide-combining power, chlorides) provides a basis for considering tubular disease. When equivocal data appear, repeated chemical analyses and protracted observation may be unavoidable.

The foregoing diagnostic plan has one serious shortcoming: it is very easy for both patient and physician to become too hopeful of the likelihood of success. It must be emphasized that such metabolic surveys of patients who have stone will produce a few triumphs but only at the cost of many disappointments. The proportion of patients in whom positive findings of decisive therapeutic significance will be found is and probably will remain a distinct minority.

SUMMARY

Many conditions may contribute to the production of renal calculi or nephrocalcinosis by causing hypercalciuria. Some of these are accompanied by hyper-

calcemia as well as hypercalciuria: primary hyperparathyroidism, hypervitaminosis D, sarcoidosis, multiple myeloma, carcinomatosis, acute osteoporosis, and Paget's disease with immobilization. In other conditions hypercalciuria may occur with normal serum calcium, as in tubular insufficiency without glomerular insufficiency (hyperchloremic acidosis) and idiopathic hypercalciuria. Careful metabolic survey of patients with renal lithiasis will disclose a few with a significant systemic malady and a significant number who may be decisively helped by discovery of a specific cause amenable to treatment.

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ROUND TABLE DISCUSSION ON URINARY CALCULI

DR. ORMOND S. CULP (Rochester, Minn.): This is going to be a very unique hour in many respects because my role became clarified only during the past 24 hours. With the ability that Dr. Nesbit has demonstrated as a moderator, this is like taking a sand-lotter and having him substitute for Casey Stengel during the World Series.

Dr. Nesbit has worked up this subject magnificently. It is the most beautifully stacked deck that one could inherit. Everybody is to have a copy of the script. Spaces have been provided on these for your respective notes. At appropriate times there will be opportunities for the audience to ask sound, sensible questions. But there isn't going to be time for that occasional case report.

We have advanced billing that this is a round table, but it will be conducted strictly as a panel discussion. Dr. Flocks is going to start things off with the "Underlying Factors in Uric Acid Lithiasis."

DR. RUBIN FLOCKS (Iowa City, Iowa): The first slide is taken from a paper by Boyce which shows relative incidence of stones in his series by chemical composition. Note that calcium phosphate stones make up 36.6 per cent of the total; calcium oxalate stones, 11.2 per cent; uric acid stones, 3.4 per cent; cystine stones, 0.4 per cent; calcium phosphate and oxalate mixed stones, 44.2 per cent; and uric acid mixed with phosphate and/or oxalate, 4.2 per cent. This essentially agrees with our experience in Iowa City. I am showing the slide to orient the group and to show the relatively low incidence of uric acid calculi. Uric acid stones apparently form on the basis of the presence of the underlying factors of stone formation, most of which are still unclear plus possibly some defects or acquired changes in uric acid metabolism or the intake excretion factors in the presence of a uric acid urine. For example, in the work of Kittredge based on a study of patients at the Ochsner Clinic, he found that 5–10 per cent of all calculi were uric acid calculi and that these occurred much more frequently in patients with gout than in patients without gout.

In our own series approximately 50 per cent of all the patients with recurrent uric acid calculi have had elevated serum uric acid which we have been unable to lower by dietary means. However very few of these have gout. Our treatment primarily has been to create an alkaline urine and this has been the experience generally. Usually, this situation has been helped by the administration of large doses of sodium bicarbonate and adequate fluids.

It is of interest, with regard to uric acid calculi, that where we have a very metabolic type of stone, a matrix is part of the stone. Dr. Boyce has definitely shown this and has also shown that the matrix associated with uric acid calculi is different than the matrix, for example, with calcium phosphate stones. This would seem to indicate that, in some instances at least, the excess excretion of the uric acid itself is not only an important predisposing factor for the precipitation of the calculi but may also be an important factor in the formation of the matrix. In other words, the matrix may be due to the increased excretion of uric acid and may not be a separate predisposing factor for stone formation.

DR. HOWARD I. SUBY (Boston, Mass.): Essentially I would agree with Dr. Flocks. I am sure that one sees a greater incidence of uric acid stones in people with gout than one does in people without gout. The thing that has impressed me, however, is that most people with gout do not have uric acid stones, and most people with uric acid stones do not have gout. Uric acid stones, like cystine stones, are formed from organic substances, and the metabolism involved is complicated and varies with different individuals to give this seemingly inconsistent blood-urine-stone relationship. Uric acid which gets into the urine to form stones may be from exogenous origin—diets high in purines and other specific protein—or from endogenous origin, a mere abnormality in the complicated body metabolism.

This slide shows that normal excretion of uric acid varies from 200 to 300 mg. uric acid per 24 hours. I think 800 mg. is considered the high level normally. If the exogenous origin is rigidly omitted by diet we often see that some patients still continue to form these uric acid calculi.

This next slide pictorially shows how uric acid stones are found in patients with a low, normal, or high blood uric acid in amounts which suggest no terribly significant relationship.

Persistently acid urine seems to be the most constant, and perhaps the most significant finding in those patients with uric acid calculi. It may well be, moreover, that these people do have some renal (? tubular) deficiency which prevents their being able to produce anything but an acid urine. This metabolic acid-base derangement may be more important than any real derangement in their uric acid metabolism.

As far as treatment is concerned we do essentially as Dr. Flocks does. We advise lowering the exogenous origin but not eliminating it; we advise alkalinization of the urine (with sodium citrate or sodium bicarbonate) to create a urine in which uric acid should not precipitate; we advise, furthermore, a huge fluid intake.

DR. FLOCKS: In our own series approximately 50 per cent of the patients with recurrent uric acid calculi had an elevation of serum uric acid which we were unable to lower by dietary means. However, very, very few of these have gout. Our treatment primarily has been to create an alkaline urine and this has been the experience generally. The usual experience has been that this condition is helped by administration of large doses of sodium bicarbonate.

We alkalinize these patients. We use sodium citrate or sodium bicarbonate interchangeably. In a comparative study of those patients with gout who have uric acid calculi and those patients without gout who have uric acid calculi (and most of our patients are the latter) it is interesting to note that the uric acid excretion in the urine is normal in the non-gouty patients so that there is no question but that other factors besides the total 24-hour uric acid excretion in the urine are responsible for the presence of uric acid stones. One of these certainly is a persistently acid urine.

MODERATOR CULP: Does anyone want to do anything except alkalinize the urine? If so, how are you going to do it?

DR. FLOCKS: This slide is put up to indicate the precipitability of uric acid as a result of a diet and as a result of sodium bicarbonate. You will see the ease with which the uric acid precipitates is much more affected by the change in the pH of the urine than by diet.

MODERATOR CULP: So much for uric acid calculi. Dr. Flocks, will you open the discussion of cystine stones?

DR. FLOCKS: Cystine stones are much more rare than uric acid stones. The normal excretion is 120 mg. for 24 hours. In persons with cystine lithiasis, one sees secretions of over a thousand milligrams for 24 hours. Cystine excretion may be increased as a result of acquired or congenital defects, but it is most likely that the patients with cystine lithiasis have an abnormal excretion upon the basis of a congenital defect affecting tubular reabsorption.

MODERATOR CULP: How are you going to treat it?

DR. FLOCKS: By high doses of alkali: sodium bicarbonate.

DR. SUBY: In an analysis of 2800 cases of urinary calculi treated at the Massachusetts General Hospital I found the incidence of cystine stones to be less than 1 per cent. I think it should be pointed out, as Dr. Flocks has just done, that this disease is usually an inherited one. I think it should be pointed out further, however, that only a very small percentage of patients with cystinuria do develop cystine stones. Matrix metabolism may be important in this connection. The unknown "stone-forming susceptibility" element is at play, and at times it makes quantitative determinations of the offending stone constituent seem of secondary importance. We treat patients with cystine stones medically after operation by giving alkalies just as we do the patients with uric acid calculi. In this latter cystine group, however, we occasionally tend to manufacture calcium stones by our regimen, and end up either with calcium phosphate, or magnesium ammonium phosphate stones in addition to or instead of the cystine stones.

MODERATOR CULP: Does anyone in the audience have anything specific he wants to bring up regarding uric acid stones or cystine stones?

FROM THE FLOOR: Would you recommend that alkalinization in the treatment of these patients be intermittent rather than continuous?

DR. FLOCKS: Our studies of uric acid precipitability indicate that it is very simple, by alkalinizing the urine, to alter the uric acid precipitability favorably. It is practically impossible to do so by diet.

Moreover, we have found with uric acid calculi that the precipitability of calcium phosphate is always improved so that percipitation of calcium phosphate is not frequently a complication of the management of patients with uric acid calculi. On the other hand, cystinuria apparently has no influence upon calcium phosphate precipitability in the urine so that when alkalinization is accomplished as part of the management of cystine stones, calcium stones not infrequently occur, as Dr. Suby just mentioned. With regard to the question of intermittent alkalinization rather than continuous alkalinization, the point here is particularly apropos with regard to cystine calculi. Apparently the big problem with cystinuria is the high excretion of cystine during the night hours. It may very well be that intermittent alkalinization with administration of the alkali just before

bed-time would be of more importance than continuous alkalinization. Also, it might be worthwhile to intermittently alkalinize urine if urinary calcium preceptibility is markedly altered by the administration of the alkali. This can be evaluated by studying the urinary calcium on various diets in association with variations of pH brought about by administration of a sodium bicarbonate management.

MODERATOR CULP: What is the importance of magnesium metabolism in cases of recurrent oxalate lithiasis?

DR. SUBY: I think it is safe to say that nobody knows. Hammersten discovered many years ago that the feeding of magnesium to animals (not human beings) seemed to decrease their urinary output of oxalates. Furthermore it was observed that animals which were forming oxalate stones at a reasonably rapid rate seemed to cease in their stone formation. In much of the old literature there is reference to the administration of magnesium for patients who form oxalate urinary calculi. It is stated that magnesium oxalate is more soluble than calcium oxalate. Daily excretion studies have thrown some questioning light on those observations, although no final proof is at hand. Another old contention was that magnesium tended to prevent oxalate absorption.

We have done no extensive work at our hospital in this important field. We have conducted one pilot experiment, however, on one of our laboratory technicians as an attempt to learn the effect of oral magnesium on oxalate excretion:

Urinary Oxalate Excretion = 15–45 mg./24 hrs.

	Urine		
	Calcium Mg/24 hrs.	Mg. mEq/24 hrs.	Ox Mg/24 hrs.
Control	296	12.4	38
$MgSO_4$	362	31.2	34

This slide shows that the normal oxalate excretion per day varies from 15 mg. to 45 mg. That is the value for oxalate and not oxalic acid. The slide shows that after oral magnesium sulfate the patient's calcium excretion did go up. There was apparently no significant effect on her oxalate excretion. It was lowered a tiny bit, but this amount is well within experimental error. From this single, and unimpressive experiment it seems that the magnesium effect is slight or nil.

DR. CORNELIUS VERMEULEN (Chicago, Illinois): Dr. Suby has mentioned one possible mechanism for action of magnesium on calcium oxalate stones. The other is that the presence of magnesium, according to Hammersten, significantly increases the solubility of calcium oxalate. It should be remembered that magnesium is by no means a trace element in urine. We have demonstrated that magnesium in normal concentration makes a very real difference in the solubility of calcium oxalate in controlled in vitro studies. The magnesium effect is apparently due to the formation of a magnesium-oxalate complex ion.

MODERATOR CULP: The medical and surgical treatment of oxalate lithiasis.

DR. FLOCKS: In regard to oxalate stones, I wish to emphasize the role of diet.

In those patients with recurring oxalate stones or stones primarily of calcium oxalate, that is, chemically, a greater proportion of calcium oxalate, dietary control has been of extreme importance from the standpoint of intake of oxalates.

Some work which has been done seems to indicate that some people excrete oxalates more easily from an endogenous point of view and respond to the intake of high oxalate diets greater than normal individuals, but we have found definitely that crystalluria of calcium oxalate and the incidence of recurrence of these stones can be helped by low oxalate diet.

I want to call your attention to some work published by Lamden on the urinary oxalate excretion of a man taking abscorbic acid. It was found that urinary oxalate was markedly increased by high intake of abscorbic acid.

MODERATOR CULP: Are there any questions from the floor about the oxalates?

DR. SUBY: What foods do you eliminate? What does that mean to you?

DR. FLOCKS: Calcium oxalate stone formers should refrain from eating large amounts of food high in oxalate. The common high oxalate foods are spinach, asparagus, rhubarb, chocolate and cocoa.

MODERATOR CULP: What proportion of stone formers have metabolic disease as an etiologic or contributory factor?

DR. KEATING: The answer is a statement of opinion, not of fact. I believe that it depends on how hard you look. I think perhaps seven or eight per cent have something wrong metabolically. Four or five per cent have parathyroid disease, and two or three per cent may have something else, but the true incidence may be much higher, of course.

DR. SUBY: I think that first, before you answer this question, you have to clarity the question. What is your definition of a metabolic disease? Are you referring to all types of stones, or just calcium phosphate stones?

DR. KEATING: I was referring to the proportion of stone formers who have hypercalcuria as causally related to the production of stones.

MODERATOR CULP: I am sure that is what was intended.

DR. SUBY: May I have the next slide, please. Dr. Henneman and several members of the Stone Clinic at the Massachusetts General Hospital have recently analyzed the data on the past 207 stone cases. Of these, there were 109 cases for which no obvious cause of stone formation could be found. Of the 207 cases, 68 patients with calcium stones (phosphate or oxalate or combinations thereof) had definite hypercalcuria (urinary calcium of over 150 mg./24 hrs. on a milk-free normal America diet).

The 68 patients with proved hypercalcuria could be divided into etiological groups as follows:

Hypercalcuria	68
Hyperparathyroidism	20
Bone disease	13
Milk-alkali-vitamin D	11
Renal tubular acidosis	6
Idiopathic hypercalcuria	18

DR. FLOCKS: When we studied a group of these patients back in the thirties, we had an incidence of hypercalcuria of over 50 per cent, which is not true, I believe, in our group of cases at the present time.

It happens that I have a slide here of a recent study made by Dr. Boyce, in which he repeated the work that we did and studied the excretion of calcium in the urine in a group of patients with stone. You will notice that a great percentage of the patients with growing stones, which are the black bars, fall in the group on the side of hyperexcretion of calcium. I am showing this slide because it seems to show an incidence of hypercalcuria, which is as high as we saw in 1939, in contrast to our present impression.

MODERATOR CULP: Would you like to say a little more about the matrix?

DR. VERMEULEN: I conceive of a stone as being composed of two types of materials, a crystalloid that is imbedded in a non-crystalloid organic material, the matrix. The matrix has been known to be present in all stones for many many years. Dr. Boyce has increased the interest in matrix a great deal recently because of the identification of mucoprotein as a component of the stone matrix. This has been confirmed in our laboratory and others. Mucoprotein *is* present in the stones. The big question, however, is what is the exact place of matrix in the process of stone formation. Is it first, in point of time, or is crystalloid first? At the present time, I don't think that anyone can answer that question.

MODERATOR CULP: What is the reason for the excessive tendency to form stones in the tropics?

DR. KEATING: I don't know, and perhaps no one does, but it has been suggested that the increased incidence among young white American soldiers in the Southwest Pacific during World War II might have reflected an undue exposure to sunlight and consequently hypervitaminosis D. Another reason that has been suggested is dehydration.

MODERATOR CULP: How is one to select those patients with kidney stones who should be investigated for metabolic disease in general or hyperparathyroidism in particular?

DR. KEATING: I think all stone formers deserve to be investigated.

MODERATOR CULP: Does anyone feel otherwise?

What proportion of patients who are successfully treated for primary hyperparathyroidism have subsequent trouble with their urinary tract? That is ambiguous, but I am sure you know what is implied.

DR. KEATING: I think there are several answers. Patients left with residual urolithiasis have usually had little trouble afterwards.

MODERATOR CULP: The stones don't become larger?

DR. KEATING: No. Then, there is another category, namely, the patient who has nephrocalcinosis and azotemia. While we hope parathyroid surgery extends his life, we are not sure it does. Many of them have not lived two years.

DR. SUBY: I think that many of the parathyroid operations done on patients in the urological wards had rather heavily contaminated urines before their parathyroid operation. A good many of those patients were exposed to the urol-

ogist before the general surgeon. These patients often had recurrent stones. Only about five per cent of the patients with uninfected urines who had a satisfactory parathyroidectomy have had further trouble with calculus disease.

MODERATOR CULP: Do you think that some of these people actually develop new adenomas?

DR. KEATING: No, except possibly in adenomatosis associated with the syndrome of multiple endocrine adenomas. We have not yet seen such an occurrence in any other kind of patient.

MODERATOR CULP: Given a patient with a parathyroid adenoma proven on laboratory grounds and a serious calculus problem which needs surgical relief, which operation should be done first, the cervical exploration of the parathyroid adenoma or the renal operation for the relief of the obstructing stone?

DR. SUBY: That depends on the severity of the urological problem. I think with chemotherapy available it is far wiser to take care of the parathyroid problem first.

MODERATOR CULP: Since the diagnosis of hyperparathyroidism is so completely dependent upon clinical interpretation and accurate blood chemistry values, how is the physician who has occasion to use the blood chemistry laboratory infrequently to interpret the values he is given safely and accurately?

DR. KEATING: The answer is he can't. The only way in which anybody can with any confidence interpret calcium abnormalities is to be familiar through experience with the variations encountered in his laboratory so as to know what to expect. This means having an idea of how accurate the laboratory is, what the random error, and what systematic errors the laboratory technician will permit. In practice, this means that somebody must see that there is a standard of normal values for that laboratory and that technique, and also that a measure of random variation is available, which usually means a replication study; that is, take a hundred milliliters from somebody and divide it into a hundred samples, and if they vary much more than .05 mg. per 100 ml. the method isn't any good, and neither is the technician.

DR. SUBY: I am sure that anybody who does work in both large and small hospitals feels that way. These important tests should not be done in a small laboratory where only an occasional such test is done.

MODERATOR CULP: Isn't it true that one gets accurate results because the tests are made frequently?

DR. KEATING: I am sure that is right. If you are running a stone clinic and adopt the practice, the laboratory is going to have lots of practice. I think it will depend upon an experienced laboratory that is doing the test every day.

MODERATOR CULP: What about the significance of alkaline phosphatase in the diagnosis of parathyroid disease?

DR. KEATING: It has no meaning with regard to parathyroid function. It only reflects the extent of osseous disease.

DR. FRANK HINMAN JR. (from the floor): What about the Sulkowitch test with people with stone disease?

DR. KEATING: A patient with good urinary specific gravity normal urea and no precipitation of oxalate with the test does not have hypercalcuria. A positive Sulkowitch test doesn't prove anything.

DR. SUBY: I think it is a valuable, inexpensive test.

MODERATOR CULP: Considerable time already has been spent on this next question. How does one differentiate the milk alkali syndrome, hypervitaminosis D and finally hyperthyroidism? I think the last was meant to be hyperparathyroidism.

Did the audience grasp what Dr. Keating said in his special talk prior to the onset of the Panel? Do you want to hear some more about the differential diagnosis of these?

DR. SUBY: I have one single slide which pictorially differentiates these three syndromes.

History		Serum Chemistries				Urine CA
		NPN	CA	P	CO_2	
Milk-alkali syndrome	Milk & alkali ingestion	↑	↑	↓↑	↑	↓
Hypervitaminosis D	Vitamin D ingestion	↑	↑	↓↑	↓	↑
Hyperparathyroidism	Stones or bone disease	N	↑	↓	N	↑

It is evident of course that the history can be very helpful in suggesting the first two of these syndromes. Serum calcium is up in all three syndromes whereas the serum phosphorus is down in hyperparathyroidism and can be up, down, or normal in the milk-alkali syndrome or in hypervitaminosis D. The nonprotein nitrogen, usually normal in hyperparathyroidism, is apt to be increased in both the milk-alkali syndrome and in hypervitaminosis D because of some renal failure. Urinary calcium excretion is increased in hypervitaminosis D, and in hyperparathyroidism, but, due to renal insufficiency may be decreased in the milk-alkali syndrome. One of the most important methods of making a differential diagnosis between these three syndromes is the CO_2 determination. This will be increased in the alkalosis of the milk-alkali syndrome, usually decreased in the hypervitaminosis D syndrome, and normal in hyperparathyroidism.

MODERATOR CULP: Before we invite any other questions from the members of the audience, Dr. Vermeulen, will you say something about the use of aluminum gels as part of the treatment of phosphate urolithiasis.

DR. VERMEULEN: It is known that the aluminum in the gel combines with the phosphate in the food to make insoluble aluminum phosphate. This reduces phosphate absorption and consequently urinary phosphate concentration falls. The effect on stone formation is easily demonstrated in the rat using the bladder foreign body technique.

In this slide you can see that the amount of stone produced in the animals fed basaljel is very significantly less than in the normal controls.

The effect of aluminum gels can be established experimentally; whether they are of real value clinically in the treatment of stone disease is another matter.

MODERATOR CULP: Does anyone in the audience have any question to ask pertinent to this particular phase of the discussion?

DR. GUSTAV LEANDER (from the floor): We in Sweden put in lots of calcium in the patients intravenously. I have seen some cases with that type of general treatment. Of course, it is rather important to advise the patient, especially those patients at the phosphate stage, not to take such injections.

MODERATOR CULP: Are there any questions you would like to direct to Dr. Keating concerning his lecture this morning?

DR. J. A. C. COLSTON (Baltimore, Md.): Might I ask a question on the difference of the stone formation in the colored and the white race? One of you gentlemen said some of the white soldiers developed a great many stones and the colored, no stones. It has been my impression that stones have been far less common in the colored race. Is there any reason for that?

DR. VERMEULEN: There is some likelihood of a hereditary factor, I think. At least in rats one can demonstrate variations in stone formation in different strains under otherwise identical conditions, and these differences are striking. It wouldn't surprise me if differences occurred in human strains, too.

DR. EDGAR BURNS (New Orleans, La.): I have wondered if there is actually a difference. We have on our university service 60 adult beds equally divided between colored and white, and there is practically no difference in the incidence of stone formation on those two services over a period of years.

MODERATOR CULP: Is your population equally divided in New Orleans?

DR. BURNS: No, not equally divided. I am talking about the in-patient service. We perhaps have slightly more full beds on the colored service than on the white service, but we went into this question some years ago. We have heard that comment over a period of years and became interested in actually looking up our own statistics. There is a very little difference in the two.

FROM THE FLOOR: In reference to the management of cystine stones, I would like to ask one of the Panel members whether there is any preference for using a citrate substance instead of soda. We have been led to believe that there are some complicating factors in using citrate in the control of the acid of the urine in cystine patients.

DR. SUBY: I know of no difference at all, other than ease of administration. We usually use a 50 per cent solution of sodium citrate.

DR. KEATING: One reason we haven't been using citrates is that our colleagues in dentistry have led us to be very distrustful as to the possible effects of continuous administration of citric acid upon teeth. It may produce dissolution of the enamel. I was thinking of Scholl's solution.

DR. SUBY: You *can't* dissolve a tooth in a solution completely alkaline. We do not use citric acid, we use sodium citrate.

DR. KEATING: We have had patients on citric acid solution who had changes.

MODERATOR CULP: This next part is going to be of profound interest to all of

you. We will give a little thought to the salicylates. What is the mechanism by which they are supposed to work?

DR. VERMEULEN: Neuberg and Grauer, chemists, reported some years ago that many substances are able to act as solubilizers for calcium phosphate. Among the materials studied by these chemists, a glucuronide was also included. The glucuronide used was menthol glucuronide. It was concluded that perhaps many other glucuronides have the capacity of increasing the solubility of the poorly soluble calcium phosphates.

With this background Prien and Walker sought to increase the urinary glucuronides in an attempt to prevent stones. They used salicylates to do this, because the salicylates are excreted in the urine partly as glucuronides. Thus the mechanism of this therapy is first that salicylates increase the urinary glucuronides, and these, in turn, increase the solubility of the insoluble stone-forming calcium salts. The implication is that stones would be prevented.

MODERATOR CULP: Do you have any experimental data?

DR. VERMEULEN: The entire rationale rests upon the solubilizing action of the glucuronides. This idea that glucuronides are solubilizers rests upon Neuberg's finding of solubilizing with menthol glucuronide. Neuberg used it in 4 per cent concentration in his in vitro tests. We sought to extend the study of menthol glucuronide solubilizing using more physiologic concentrations. The 4 per cent glucuronide concentration used by Neuberg is much beyond that occurring with salicylate therapy.

May I have the next slide please. Permit me to disregard the methods used for determining solubility and take my word for it that the height of the bars indicates the solubility. The water control is shown on your left. Over on the far right is a bar showing calcium phosphate solubility in a 3 per cent menthol glucuronide solution. There is a very real increase in solubility with 3 per cent menthol glucuronide. However, at more physiologic levels there is a negligible effect on solubility, as seen in these other bars.

Human experiments were also done in which two normal individuals were intermittently fed salicylamide. Urines were collected from both patients daily and solubility of calcium phosphate was determined in the urines over the period of two months. Now, many things will change the solubility of the calcium phosphate in the urine from day to day. It was hoped, however, that these variables would iron themselves out because of the duration of the experiment, and they seemed to have done that. But we were unable to find any difference between the solubility in the control periods and the periods when salicylamide was being given. We concluded that salicylamide therapy rests on uncertain ground.

MODERATOR CULP: Don't you have some clinical results?

DR. SUBY: We haven't done much chemical experimentation on salicylates, actually. I have one slide here, however, of a single human experiment.

MODERATOR CULP: What we would like to know is how useful this method may be.

DR. SUBY: This is just a short simple experiment studying the urinary mag-

nesium, calcium, and oxalate excretion of a patient on control regimen, and on a regimen of 3 gm. aspirin/24 hours:

Effect of oral salicylates 3 gm. aspirin /24 hrs.

	Urine		
	CA Mg./24 hrs.	MG mEq/24 hrs.	OX Mg./24 hrs.
Control	202	7.5	37
Salicylate	268	7.16	33

It is interesting to note that aspirin had practically no effect on the magnesium and oxalate excretion, and that in this one instance the calcium excretion was increased. These are merely metabolic observations however and neither condemn nor condone the solubilizing effect of the aspirin-produced glucuronides. Further concise accurate work is needed to evaluate whether this theoretically increased solubility factor is of practical stature.

I have used this salicylate therapy in 15–20 patients, but have been unimpressed. The cases in which it was tried, however, have been poor ones and my final judgment has not been made.

DR. FLOCKS: I want to report preliminary studies on two patients, one receiving sodium salicylate and the other lithitrol. In the second patient, the urine pH became acid. That calcium precipitability was improved. In the first subject, it was not improved.

MODERATOR CULP: What is your impression?

DR. FLOCKS: In our clinical experience with a relatively small number of cases, we have not been impressed.

DR. VERMEULEN: We could not demonstrate any value in experimental animals. We used rats with foreign bodies taking animals of two different strains which make different kinds of stone. However, salicylates in the rat are not handled as they are in human beings. Glucuronide excretion is not greatly increased in the rat.

But there is another substance, isoborneol, which, when fed to rats increases the glucuronide excretion greatly. (I am told by Dr. Prien that at one time he thought of using isoborneol as a means of increasing the glucuronide in the urine of patients.) But with isoborneol no effect on foreign body stone formation was found in our rats even though a good glucuronide response was obtained.

MODERATOR CULP: Let's find out how the patients do. What is your impression?

DR. KEATING: We haven't done any controlled study, but we have been unimpressed with the small group of patients for whom we prescribed the drug.

MODERATOR CULP: Here are four panelists unimpressed by salicylates, and yet everybody, I am sure, has been impressed by the perfectly honest and conscientious reports by others. This might be a good time to get opinions from the audience. I know a lot of aspirin has been dispensed. What is the feeling of any of you as to the efficacy of it? Would anyone like to volunteer his excellent results? Will anybody who has been impressed by the administration of the

salicylates during the past year please raise his hand. (No response.) We are convinced that aspirin reduces encrustations in and on indwelling tubes and catheters but have found it to be disappointing otherwise.

We shall proceed to phytate.

Dr. Vermeulen, I think you had best introduce that.

DR. VERMEULEN: Phytate is essentially a benzene ring with six phosphate radicals attached to the carbons. It combines with calcium and thus impedes the absorption of calcium. Consequently, the calcium excretion in the urine is reduced. In rats, it can be shown that the administration of phytate will impede foreign body stone formation.

May I have slide 3? These animals, which received phytate, had little or no stone formed on the foreign body as compared to the controls. The urine chemistry studies on these animals are very interesting. With phytate, the calcium is reduced to one-third the control level, but the phosphate is increased to three times the normal. Thus, the reduction of calcium would seem to be balanced by a corresponding increase in phosphorus, and yet, stones were not formed. More on this later, perhaps.

DR. SUBY: May I have the next slide, please? It is interesting to review the history of the study of sodium phytate. About twenty-five years ago Mellanby found that whole wheat—even in the form of whole wheat bread—tended to cause demineralization of bone. By careful analysis it was found that the active causative agent for this phenomenon was phytic acid. Phytate combines with both calcium and magnesium thereby increasing the fecal calcium and magnesium and lowering the urinary calcium and magnesium. Part of the decreased urinary calcium is due to the high phosphorous effect, but Henneman and Albright have shown that the phosphorous effect alone does not account for the entire decrease. There seems to be a specific "phytate effect." In the Massachusetts General Hospital Stone Clinic we have used this drug for the past two years. It is given in the form of a 15 per cent solution of sodium phytate, and the dosage we have used is 9 grams daily. Approximately forty-one patients have been treated with phytate, and the results have been encouraging. Diarrhea may be a complication, but we have never had this complication become a serious one. Certain investigators, including Walker, have pointed out the fact that phytate loses its effectiveness after prolonged administration. We have had patients on this drug for eighteen months with no loss in their metabolic response to it. There may be individual variation to this "length of response."

MODERATOR CULP: Would anybody like to volunteer how the patients do?

FROM THE FLOOR: Diarrhea may be very serious with phytate. In 20 patients, we have had five who have had severe diarrhea, and under no circumstances could we get the patients to resume treatment. We have tried changing the size of the dose, and these are all patients who are on the metabolic unit. They were being studied carefully.

DR. SUBY: How much were you giving?

FROM THE FLOOR: I don't know exactly. It was the regular dose. We cut it down to a third, and they still had diarrhea. In two instances, the patients had to have intravenous therapy to straighten them out.

DR. SUBY: We have 36 out-patients who have taken it and five in-patients on the metabolic wards who have taken it. We have had some diarrhea, but not severe.

DR. KEATING: We have had some diarrhea, but not severe enough to make the patient stop the medicine.

Might I have the two slides? The first one is a balance study of the effect of phytate. This is plotted according to the technique of Reifenstein and Albright. The intake is plotted down from the zero line, and the output including feces, (which is the patched area), and urine (which is the clear area) is plotted up. When the bar is above the zero line, the balance is negative, and when below, positive. It shows the difference in the distribution of calcium in this patient and also shows the tremendous increase in inorganic phosphate. The question was raised as to whether the increased inorganic phosphate counterbalances the advantage regarding stone formation by reducing calcariuria. I understand Dr. Henneman doesn't think so.

(Slide.) Here is another patient in whom a similar study was done. We interpret it as suggesting that phytate does wear out. As you can see, these balance periods, which are six-days each, are separated, number six from number five, by 118 days, at the end of which time phytate no longer had effect on the urine. The patient did not receive phytate during this interval.

MODERATOR CULP: Dr. Flocks has some data he acquired from Dr. Boyce.

DR. FLOCKS: Dr. Boyce was able to prevent the calcification of a very definite matrix, which could have acted as a nucleus for calcium stones in several instances by the administration of sodium phytate.

MODERATOR CULP: Do any of you have anything further to add, which might have some clinical value?

Dr. Flocks, will you consider hyaluronadase and the role it has acquired.

DR. FLOCKS: You are familiar with the precipitation of urinary crystalloids. In our clinical experience, we have found it to be of no value, and in experimental studies on patients—small groups of subjects—we were unable to show that the injection of hyaluronide given subcutaneously had any influence on precipitation.

MODERATOR CULP: Would anybody like to take up the cause? Dr. Vermeulen, will you now introduce the question of hexametaphosphates?

DR. VERMEULEN: It is a water softener. Calgon is a trade name for sodium hexametaphosphate. It has the capacity of increasing the solubility of calcium salts. Recently calgon was suggested as a possible stone preventive. We did an experiment some years ago on rats with calgon by mouth and found it did impede stone formation, but we didn't understand it, and we never reported it. Pyrah and his group in England recently reported that their studies showed that hexametaphosphate prevented stone formation in rats.

We repeated the experiment and found the same thing; that the feeding of hexametaphosphate by mouth prevents stone formation on foreign bodies. However, again the chemistry studies of the urine were interesting. The calcium goes down. The phosphate goes way up. Yet, there is no calcium phosphate stone formation. We gave, then, equivalent amounts of phosphate, but this time as the orthophosphate. Again, we got the same result, no stone forming on the foreign

body, a fall in urinary calcium, but with phosphorus going way up. This is a paradoxical phenomenon in which stone is prevented by feeding one of the ions that go to make up the stone. We believe that the hexametaphosphate action is entirely explainable from the fact that you are giving the phosphate. It isn't anything fancy. If you use orthophosphate, the same thing happens. The phosphate combines with calcium in the gut impairing its absorption. It is strange that one can prevent stones by feeding one of the very ions that form part of the stone salt. What is more paradoxical is that not only phosphate will do this. Foreign body stones in rats can also be prevented by feeding very large amounts of calcium.

It is possible to prevent calcium phosphate stones by feeding sufficient amounts either of calcium or phosphate, the two components of the stone. It was hard for us to believe this but we have repeated the experiment several times. It always comes out the same way. We certainly do not understand all this but it makes one think more and more of the intestine as an important site for future investigation concerning stone formation.

DR. SUBY: We did a lot of work on calgon before the war when we were investigating the value of citrate and calgon as calcium solvents. We found it extremely irritating to the rabbit's bladder, and on the few rabbits given calgon by mouth, not enough experimental data were accumulated. Just as it takes a male germ cell and a female germ cell to form another organism, so also must it take a calcium ion and a phosphate ion to form a calcium phosphate stone. There is no mystery about that.

DR. VERMEULEN: It is quite true, but it does serve to point up that we have an unhealthy tendency to equate stone disease either consciously or subconsciously with calcium. We fail to keep in mind that phosphate is there, too, and that it is equally important. At least, that has been my tendency. I recognize now that it is wrong to unconsciously equate stone disease in a rough rule-of-thumb way with calcium. We haven't given enough attention to phosphate.

DR. FLOCKS: Could you tell me what happened to the hydrogen ion concentration?

DR. VERMEULEN: It was controlled so as to be equal in all groups except those receiving high calcium, where the urine was more alkaline.

MODERATOR CULP: It is obvious we aren't going to be able to cover all the ground laid out for us. I think we might ask Dr. Suby about his convictions regarding the current status of dissolution. It seems there has been a revival involving calculi in polio patients. It has received some attention in the lay press.

DR. SUBY: This story is a peculiar sequence of events. A patient of mine brought in a newspaper clipping about two months ago from a New Orleans newspaper. It stated that urinary stones were now being dissolved. I read the article with great interest. It was from a hospital in California and the reporting doctor was a Dr. James Elliot. I am sure quite a few men in this group remember Dr. Elliot overseas. I didn't know if it was the same man, but I wrote him a letter stating that I had a copy of the clipping, and that I wanted to know what solvent he was using. He wrote back immediately that he had been using solution

G and that he was getting good results. He had reported to the polio group in New Orleans. I asked him if he had any x-rays that I might take with me to the American Association of Genito-Urinary Surgeons.

(Slide.) These are the data of James Elliot. This work was from the Fairmont Hospital in San Leandro, California, one of 15 polio centers. He had treated seven patients with solution G. In three of these all of the stones had been dissolved; in another three, 50 to 80 per cent of the stones had disappeared under treatment and in one there was no change. He was very honest in his letter. He said that all of these patients were people he had operated upon once, twice, or three times, and that they were forming recurrent stones rapidly. He thought he would try dissolution therapy because time was of no importance. He had used two plastic ureteral catheters, an inlet No. 4, and an outlet No. 7.

These are Elliot's slides. This is a recurrent stone that he said was a little bit larger on the day when they started the irrigation. They started the irrigation on the first of June.

The second one, please. This is after three days of irrigation through the ureteral catheters, showing that the stone is about half its original size.

(Slide.) This is about two weeks later. The stone is practically gone. The other slides are of poor quality, but I have them if you are interested. At least we are up to date on the Elliot report.

MODERATOR CULP: How about vibration therapy?

Dr. SUBY: So far as I know there is at present no practical clinical application of vibration therapy in the treatment of urinary stones.

MODERATOR CULP: I want to thank the four "Men of Distinction" who served on this panel. It has been a pleasure to be here. I am sorry that Dr. Nesbit wasn't able to carry out his original plans and that we were unable to cover all details of this broad subject.

ROUND TABLE DISCUSSION ON URINARY DIVERSION

DR. WYLAND F. LEADBETTER (Boston, Mass.): Urinary diversion is a subject which is difficult to cover in its entirety in the course of this discussion, but we hope that we shall be able to bring out some points in regard to the various procedures and something of their application. I am sure, to you, the choice of procedure for urinary diversion, today, particularly since so many different methods have been described and advocated, becomes a rather difficult matter. It is to me.

In the course of this discussion I think we have to consider cutaneous ureterostomy, conventional ureterosigmoidostomy, the loop procedures such as the ileal loop, possibly the isolated sigmoid loop, formation of a rectal bladder, either with a proximal colostomy or done according to the technique of Gersuny and more recently described and advocated by Johnson, and wet colostomy.

To complicate the matter somewhat, we have to take into consideration the reason for diversion such as exstrophy, neurogenic bladder dysfunction, patients for whom cystectomy or more extensive pelvic organ excision is necessary. It has also to be considered with reference to the normal or abnormal upper urinary tract.

It has seemed to me as I thought over this problem that perhaps, first, it would be well to consider diversion in terms of those patients who have either a benign lesion or a malignant lesion with a good prognosis; in other words, patients in whom long-term survival can be expected on the one hand, and then patients with a poorer prognosis and probable shorter term of survival. In order to start, I thought it might be well to get the opinion of members of the Panel as to how they would accomplish urinary diversion in the presence of either benign disease or relatively benign disease in which long-term survival can be expected. Such patients might have exstrophy, neurogenic disease, irreparable vesicovaginal fistula, extensive but low grade carcinoma of the bladder. I wonder if each one would be willing to express his opinion concerning this matter?

DR. JUSTIN CORDONNIER (St. Louis, Mo.): So far as I personally am concerned, there has been a great change in my thinking during the last five years and there may be a similar change in the next five. My impression is based on an analysis of the literature and my own personal experience. At the present time, I believe that the best place to collect urine is outside of the body and that the ileal conduit is the best way to get it there. Therefore, as of now my feeling is that ileal loop urinary diversion gives the patient the best chance of survival with a normal upper urinary tract. It should be stressed that no individual probably has a normal expectancy because, as Dr. Harry Spence has so often said, one is dealing with damaged goods, and one has to do the best he can.

DR. WILLIAM WALLACE SCOTT (Baltimore, Md): I agree with Dr. Cordonnier that at the present moment the best form of diversion of the urine for the patient who has a relatively benign condition is ureteroileostomy. We have had no experience with the Gersuny procedure. I think it remains to be seen, not only

after ureteroileostomy but after other procedures, what the long-term results will be.

DR. NORRIS HECKEL (Chicago, Ill.): Honestly, gentlemen, I feel quite inadequate in substituting for Dr. Baker on this panel. My experience in the field of urinary diversion concerns itself almost entirely with ureterocutaneous anastomosis. I have had no experience with the so-called artificial bladder.

In diverting the urinary stream by the ureterocutaneous method, I appreciate the fact that there are disagreeable things as far as the patient is concerned. Certainly the inconvenience in the wearing and care of the apparatus can not be minimized. However, we can not agree with those who say that ureteral catheters must be used by patients who have undergone ureterocutaneous anastomosis. Some 20 years ago I developed a technique which we have been and are using, that does not require permanent use of ureteral catheters. This eliminates many of the discomforts of the apparatus.

We have observed not a few patients long enough now to know that a normal upper urinary tract can be maintained by ureterocutaneous anastomosis.

MODERATOR LEADBETTER: Do you have any points relative to the technique of performing cutaneous ureterostomy that you think might be of interest?

DOCTOR HECKEL: I certainly do. This question reminds me of a golf game. If you can't shoot in the seventies, don't blame the clubs, the course or the ball.

So far as cutaneous ureteroanastomosis is concerned, two things are necessary. First, the operation must be done meticulously. We use the same instruments that the ophthalmologist does in a lens operation on the eye. Secondly, one has to carefully watch the patients postoperatively. If the catheter doesn't work and urine drains around the catheter, infection is apt to develop at the site of anastomosis; the ureter will retract and stricture is likely to develop.

MODERATOR LEADBETTER: I believe you told me last night that some of your patients have had diversion by the Merricks-Gilchrist technique. Would you be willing to say a few words about this procedure.

DR. HECKEL: When the Merricks-Gilchrist operation was first presented, we decided to refer to the authors some of our patients who had extensive cancer of the bladder; not because I have any inferiority complex about doing radical surgery, but because this is a special type of operation. Those whom we referred to Doctors Merricks-Gilchrist have done very well in the majority of cases, and I am sure the reason that these patients are alive today is because of the operation. On the other hand, I have seen some rather—should I say discouraging—complications, which I believe are caused by many factors. I certainly would not criticize any operation on that basis. Any procedure that is comparable in duration and tediousness is bound to be followed by complications, but you should not condemn the technique because of that.

MODERATOR LEADBETTER: The opinion of the Panel, therefore, concerning urinary diversion for situations in which one may expect long survival seems to be, in spite of Dr. Heckel's comments on cutaneous ureterostomy and the Merricks-Gilchrist procedure, that the ileal loop type of diversion is most desirable.

I would like to ask members of the Panel if when dealing with a patient with

extensive but operable carcinoma of the bladder in which the upper urinary tract is essentially normal, they would have the same or a different opinion.

DR. CORDONNIER: I would do the same thing. Let me say a word about ureterocutaneous anastomosis. One swallow doesn't make a summer. In order to assess the value of any procedure, one has to have a series. I am sure all of us could show good results from this type of urinary diversion but one has to have a controlled series and analyze the good with the bad. I tried to do this from a study of the literature but could find only two series that had been so analyzed. The result in one was approximately 50 per cent long-term morbidity.

DR. HECKEL: I think, again I would choose ureteroileostomy.

MODERATOR LEADBETTER: It seems that this should resolve the matter of urinary diversion in all situations. However, I don't think the matter is as easily resolved as this. We have been doing ureterosigmoidostomy for a number of years with unquestionably many good results. In my mind, there is nothing like a sphincter to control urine and it would seem to me that I might still choose ureterosigmoidostomy or some modification in treating certain patients, realizing that it is not necessarily a terminal procedure. If patients do not do well, additional surgery is always possible. Since many patients do do well, it may not be necessary to do supplemental surgical procedures in any large number of patients. I might say that of the patients I have been following I have had to do secondary diversion operations in only two patients because of hyperchloremic acidosis.

I would like to ask each member of the Panel if he would ever do conventional ureterosigmoidostomy.

DR. CORDONNIER: I am afraid, perhaps I have gone a little far to the left, and I don't think one can condemn ureterosigmoidostomy completely. We have analyzed our cases and found that 70 per cent have done quite satisfactorily. It is the other 30 per cent that worries me. I believe that ureterosigmoidostomy has a definite place, certainly in palliation where longevity is not anticipated. As I have indicated, a fair percentage of these patients do quite well.

DR. HECKEL: I have little to add to that. I believe I would use the conventional ureterosigmoidostomy as a palliative procedure.

DR. SCOTT: I am not sure that I would.

DR. LEADBETTER: You have some statistics on this, Dr. Cordonnier.

DR. CORDONNIER: An analysis was made of long-term results with ureterosigmoidostomy. I tried to do it as fairly as I could when I went through all the literature two years ago. You will have to take my word for it that 65 per cent of the patients seemed to have good results judged on the basis of morbidity, sepsis, survival, etc. Harvard and Thompson's series is the best on exstrophy. They have accurate followup on 128 cases, of which 74 per cent survived 10 years. One must realize, however, that a child with exstrophy may have other congenital anomalies so that these figures may not be as bad as one might think.

MODERATOR LEADBETTER: Since we have no comparable figures based on the use of the ileal loop for exstrophy of the bladder and are not likely to have for some time it would not seem possible to pursue this matter further.

My own feeling about urinary diversion is that we need more information.

Why do certain patients do well after ureterosigmoidostomy and other patients do poorly? There must be additional factors aside from stricture at the site of anastomosis and pyelonephritis. For instance, why do some individuals reflux urine freely into the transverse colon and even to the cecum whereas others do not seem to do so? May it not be possible in some that enzyme action in the bowel favors more active exchange of electrolytes? Perhaps there are factors which can be modified. Before we assume it is impossible to use the large bowel to hold urine we must have more information.

I would like to ask members of the Panel if in a situation which warrants construction of a rectal bladder, would this lead to a lessening of electrolyte exchange or do the members believe that it would make no difference. I have recently constructed rectal bladders with a proximal colostomy and eventually I will have a series of cases with ureterosigmoidostomy, ileal loop diversion, and rectal bladders which will allow comparison of electrolyte absorption under these various conditions. I wonder if members of the Panel would be willing to comment on experience with the rectal bladder?

DR. CORDONNIER: I will be very brief. I think it boils down to which is the easier to care for: an ileal loop draining urine, or a colostomy. This certainly is one factor to consider. In our experience we have had a child who originally underwent the Boyce-Vest procedure, and on whom we subsequently did an ileal loop. The mother stated that it was easier to handle the ileostomy. Since we are discussing the problem, we must realize young children have not developed bowel control. In addition, some cases of exstrophy may have an incompetent rectal sphincter. If a rectal bladder has been formed the child may lose urine continuously from the rectum. One wonders if they will not develop a small rectum.

DR. SCOTT: Several years ago I tried to clarify in my own mind what were the principles of a good operation for diversion of the urine. One of the first principles I thought was important, and others have agreed with this, is that it is important to have a small absorbing surface of bowel. That is, the length of the bowel loop should be short. If one fashions an ileal loop or a rectal pouch, it should be reasonably short. Second, it seems important that runoff of urine be rapid. I think this is nicely demonstrated when one attempts to bring a person out of coma incident to hyperchloremic acidosis, secondary to ureterosigmoid anastomosis. One can work hard trying to regulate electrolytes, but it is most important to place a rectal tube to insure rapid runoff of urine. Third, I certainly feel there there should be no fecal contamination. This can be arrived at by a colostomy above a rectal bladder, or by diversion of the urine rather than the fecal stream as by ileal loop. It is certain on the basis of physiological studies that all patients will absorb sodium, chloride and ammonia from the large bowel and that they will also excrete potassium. It is possible to produce hyperchloremic acidosis in a normal individual by continued administration of urine enemas.

Recently an article on the electrolyte imbalance after ureterosigmoidostomy was written by Dr. Thomas Stamey and appeared in the December 1956 issue of SURGERY, GYNECOLOGY AND OBSTETRICS. I recommend it to you. One thing that

has interested us very much has been potassium deficiency. Dr. Stamey, during the past year, went over all the files of individuals who have died in the Johns Hopkins Hospital following conventional ureterosigmoid anastomosis. Some of these patients had lived a long time and apparently had done quite well. As I recall, 17 of a total of 57 had specific lesions in the kidney which could be ascribed to potassium deficiency. I think this is important. Certainly, ureterointestinal anastomosis has been carried out successfully in many instances, but we should be interested in the bad results in 30 per cent.

I think we should analyze long term results from these various new procedures in 5 to 10 years. It has only been about seven years since Hudson and Goodwin proposed an operation whereby they modified the Maydl operation, splitting the trigone and putting the ureters with cuffs of surrounding bladder into the rectum, as a form of diversion of exstrophy. There were five cases, possibly six. Now, after seven years, all these cases have gone sour. We had felt because of our experiments in the dog, where it looked as if we could maintain the ureterovesical sphincter, that we could do the same in the human. Apparently, such is not the case.

MODERATOR LEADBETTER: It would seem that the members of the Panel feel that free conduit diversion by ileal loop represents the safest method of urinary diversion. I have been unable to get the Panel to commit itself concerning the use of ureterosigmoidostomy or any of its modifications except for palliative purposes. A rectal bladder either with proximal colostomy or perineal sigmoid pullthrough, in other words the Gersuny-Johnson procedure, does not seem to be acceptable. I wonder if Dr. Cordonnier would give us information which substantiates his views. I can remember a few years ago when Dr. Cordonnier felt just as strongly about the effectiveness of ureterosigmoidostomy. I feel that because of his extensive experience we should pay a great deal of attention to what he has to say.

DR. CORDONNIER: I don't feel that I am overly enthusiastic. Actually, what has happened began because I had occasion to be associated with Dr. Bricker when he started his work. He had to find some place to put the ureters because there was no rectum left. He did not like wet colostomies. Consequently, the ileal loop evolved.

The results he obtained, and I had occasion to view his pyelograms and to see the way his patients were getting along, seemed to be quite superior. We have been doing this procedure approximately four years. I would like very briefly to run through our results because we have been fortunate enough to accumulate a considerable series.

(Slide) We have tried to be hypercritical in analyzing these cases and I think actually the results are somewhat better than statistics indicate. We have analyzed the renal status of all patients. I think if an individual has one poor kidney and one good one, one has to consider the result bad. I have, therefore, analyzed the patients on the basis of individuals and have tried to be fair.

We have had 98 cases in which we have done ileal loop urinary diversion. Only 33 had normal pre- and postoperative pyelograms. Thirty-three of the remainder were improved. Thirteen remained relatively stationary; in other words, were

unimproved. It should be noted that these were bad to start with. Fourteen of the 98 (14 per cent) were unsatisfactory. Six patients have been lost to followup.

A word in regard to our early complications. We had no significant complications in 68 out of the 98 cases. Wound separation occurred in seven. Complications involving the ileal stomas were primarily stenoses, and occurred because we did not make them right. We now remove a button of fascia, a button of skin and we attach the peritoneum so that we do not get a hernia around the stoma. In three patients urine leakage developed and in three, intestinal obstruction.

(Slide) These are our late complications. In three patients recurrent tumor developed in the ureters. Twelve died from metastatic carcinoma. Our major late complication has been associated with the stoma itself. Sepsis occurred in seven, roughly 8 per cent. We have noted obstructive uropathy in 10 due to technical difficulties. We probably did not transplant the ureters as well as we might have. Twenty-nine patients had no complications early or late. In view of these statistics, we have established a base line for ourselves.

MODERATOR LEADBETTER: I think there are technical details in regard to the performance of the ileal loop or ureteroileostomy that are worth considering because, after all, none of these procedures can be better than their technical performance. I presume you would agree, Dr. Cordonnier, that the cases in which urosepsis developed after operation were primarily the result of poor anastomoses.

DR. CORDONNIER: Not necessarily. Some of them had dilated upper tracts to start with. We have had no compunction about anastomosing dilated ureters to the ileal segment, even ureters that were obviously badly damaged. I do not think the incidence of sepsis is entirely due to faulty technique.

DR. SCOTT: I have three slides which illustrate the Bricker procedure. I hope that Dr. Cordonnier will comment on these because he has had much more experience than we have had. I enjoyed very much Dr. Baker's and Dr. Graf's movie which illustrated this procedure so nicely. Dr. Stamey believed it was wise to tie the ureter after the ureter was isolated, especially in children, prior to isolation of the segment, to cause dilatation of the ureter prior to transplantation. I myself do not do this. The ureters are simply isolated, the left through the mesocolon, and both are transplanted into the ileal loop. One of the most important points about this operation is to create a real defect through all layers of the abdominal wall so as not to constrict the ileum. In creating this defect we attempt to bring the tissues to the midline with Allis clamps, then excise a buttonhole through all layers of skin, subcutaneous tissue, fascia, muscle and peritoneum. We turn the end of the loop back on itself. Our ureteral anastomosis is done with a single layer of 0000 chromic catgut sutures. I think it is most important to make the loop of proper length. The loop can be much too long causing pooling of urine within the segment. I feel also that a loop should not be too short and that its pedicle must necessarily be adequate to insure blood supply. I think one of the most difficult experiences one can have is to operate upon a patient with a short, thick mesentery which one cannot transilluminate. In one instance, I had to prepare a second loop. In this instance we could not transilluminate the loop to visualize the blood supply. It takes a good 3½ hours to do this procedure exclu-

sive of cystectomy but we feel that the time spent has been justified in the good results obtained.

DR. CORDONNIER: I would like to say one thing. By the time this procedure got to Baltimore, it had speeded up approximately an hour. It is probably the time change.

I would like to emphasize and re-emphasize the points that Dr. Scott has so ably presented. We worked this out through trial and error. We must have made every mistake in the book. May we have Dr. Scott's last slide again? I concur heartily that one must be very accurate in establishment of the length of loop. It is a mistake to get the loop too long. We use from 6 to 8 inches. If too long there may be multiple kinkings in the pelvis which lead to poor drainage. On the other hand, if the loop is too short, one has difficulty anastomosing the left ureter properly. One has to judge the length of loop by the thickness of the abdominal wall. The blood supply of the loop is most important. The way we have attempted to maintain this is to be very careful not to make a long cut down into the mesentery but maintaining a good broad base of the mesentery for the loop. I only cut as far into the mesentery as is absolutely necessary to bring the loop out through the skin. We also close the rent in the mesentery transversely because we feel if closed otherwise there is a tendency to constrict the loop.

Another thing is that I use a double layer of sutures on my ureteroileal anastomoses. This is a little safer to my way of thinking.

DR. SCOTT: Dr. Cordonnier does not use catheters except during the time he is making the anastomosis to assure continuity between the ureters and the ileum. We don't use catheters at all. We affix the Rutzen bag to the abdominal wall immediately upon having closed the abdominal incision.

DR. CORDONNIER: That is exactly the method we use.

MODERATOR LEADBETTER: It might be well to note in passing that not all of Dr. Cordonnier's patients have done perfectly, and I would like to ask him what he recommends when trouble arises following an ileal loop procedure. If one does ureterosigmoidostomy, one can proceed to the formation of a loop. If one gets into difficulty with the loop, I assume, if obstruction is present in the lower end of one or both ureters, it could be corrected. What do you recommend, Dr. Cordonnier?

DR. CORDONNIER: This is a hypothetical question which doesn't occur. The ones I have listed as unsatisfactory, I think, have been due to one of two things, either stenosis of the ileum where it goes through the abdominal wall, or a defective ureteral anastomosis. Under such circumstances, one could reimplant the ureter in the loop without too much difficulty.

One thing not stressed enough is regular periodic examination of these people by intravenous pyelography. It is simple following ileal loop procedure to put a Foley catheter into the loop, inject dye, and get ileoureteropyelograms.

I think these patients should be followed every three months for the first year by intravenous pyelography and at suitable intervals thereafter for an indefinite period of time. They cannot be considered normal individuals. If we watch them carefully and do not wait until they get into serious difficulty, we shall be

able to prevent development of serious renal impairment which we have often failed to do in the past.

DR. SCOTT: I would like to show three slides. The first illustrates tubular lesions in the kidney secondary to potassium deficiency. (Slide)

(Slide) This is the pyelogram of a six-year old child made in May 1956. Five years earlier the Hudson-Goodwin modification of the Maydl operation was done. During the past five years, pyelonephritis and stones developed in the left kidney for which nephrectomy had to be done. Last May the child suffered from moderately severe hyperchloremic acidosis with a nonprotein nitrogen of 48. An ileal loop was constructed. (Slide 3) This is a ten-minute postoperative film. It shows much less dilatation of the right upper urinary tract, the only one that remains. Serum electrolytes are normal and the nonprotein nitrogen is 38. This shows what can be done. We have carried out this procedure now in four instances to provide a solution for unsatisfactory ureterointestinal anastomosis in our institution. It is very impressive to see a child's renal function re-established and restored to relative normalcy.

MODERATOR LEADBETTER: I don't think we should leave this discussion without bringing up the matter of wet colostomy. It does become necessary to remove both the rectum and the bladder occasionally. It has been my practice to perform wet colostomy in these individuals. What would you recommend if it is necessary to remove both the rectum and the bladder?

DR. CORDONNIER: I will still say ileal loop urinary diversion.

DR. SCOTT: My feeling is that wet colostomy is 'for the birds.'

MODERATOR LEADBETTER: My impression is contrary to yours. All patients for whom I have performed wet colostomy have done extremely well. I am not sure it would be possible to do ileal loop in addition to extensive surgery for removal of the pelvic viscera in all cases. I think it may be a question of what should be done under certain circumstances but my impression is that wet colostomy has a place.

DR. SCOTT: I am not so sure.

MODERATOR LEADBETTER: My impression from listening to your discussion is that ileal loop urinary diversion, as has been described, constitutes in the minds of the Panel the safest method of urinary diversion. I think we will have to drop the matter right here.

PRESIDENT DEAN: Are there any questions from the floor?

DR. JOSEPH H. KIEFER (Chicago, Ill.): The patient's comfort hasn't come into this discussion at all yet. I think it should somewhere. Freedom from appliances is a worthwhile objective. It is obvious that personal considerations come into decisions relative to these matters. For instance, I see a number of men smoking here. Although statistics may tell them that their life may be shortened, they prefer smoking because they enjoy it. Many patients might bargain off a little time exchanging safety for a little more comfort which comes with the non-appliance type of urinary diversion procedure.

Another thing that might be mentioned is that statistics on survival and complication of ureterosigmoidostomy are based on long-term observation. The long-

term bad results are in. These patients were operated on when procedures were not nearly so safe or established as at the present time. Results are being compared which are not necessarily comparable. I feel that patients operated on by ureterosigmoidostomy have a much better chance of survival now than they did 20 years ago.

DR. JOHN LATTIMER (New York, N. Y.): Is it agreed that a urinary stoma is preferable to a fecal stoma?

MODERATOR LEADBETTER: This must be a matter of opinion. I see no way to answer this satisfactorily. In dealing with patients, I usually state the various procedures that can be done, the risks involved, and try to have the patient see other patients who have had the various types of operations so that they can see the appliance, if it is to be used, ask questions about the care of an ileal loop or the performance of a rectal bladder or ureterosigmoidostomy, then let the patient choose the type of procedure, if it is feasible. I believe it is much too soon on the basis of our experience with ileal loop or other diversionary procedures to be certain yet as to what we will eventually want to recommend. We can never come to an agreement on this matter because there is no individual surgeon who has performed all the various types of diversionary operations in sufficient numbers to be able, himself, to compare the results. I think the only way we can leave this is to point out what has been accomplished so far, what the relative risks of various procedures are, their relative advantages and disadvantages and to wait to see what the future shows is probably safer or more satisfactory. I think it might be interesting in view of the discussion that has preceded to ask the audience what their preference would be in providing diversion for exstrophy. How many would utilize a procedure similar to the Boyce-Vest technique? (Four members raised their hands.) How many would carry out ureterosigmoidostomy? (The majority raised their hands.)

DR. GEORGE F. CAHILL (New York, N. Y.): It has been my experience to have followed several cases of exstrophy through at least 25 years of their lives; the exstrophy not having been repaired, the patients themselves are smelly, abhorrent to themselves and everyone. Many attempts at repair were carried out and then finally ureterosigmoidostomy was done because of competent rectums. One returned at age 44. She had moderate dilatation of the upper urinary tract. It was proposed that she go to something else. She said she would commit suicide first.

DR. CORDONNIER: I have not had one patient complain that he was having trouble managing the bag or was unhappy about it following ileal loop procedure.

DR. SCOTT: We have had the experience of the mother saying she much preferred the new situation (ureteroileostomy) to that of the old where both urine and feces were passed per rectum.

MR. RICHES (London, England): I feel that no one has brought out the difference in behavior between the malignant and the non-malignant case. We had a collective followup of approximately 1000 cases of ureteroenterostomy in which the difference in survival was most striking. Those with malignant disease

generally did much worse from the point of view of hyperchloremic acidosis. You can do to the benign cases what you can't do to the malignant ones.

I was glad to see that Dr. Leadbetter included the benign and the relatively benign cases in one group. Some cases must have cystectomy and have to have urinary diversion. With some, one gets into trouble. From my own experience, on my first hundred cases of total cystectomy for malignant disease, only five died from hyperchloremic acidosis. This was at the time when we did not recognize it. They would not have died now. One can prevent it and one can treat it. One can prevent it if the patient is instructed to take a regular dose of alkali, 3 gm. sodium bicarbonate. He must void every three hours. He must be made to get up once in the night. One must make him use an alarm clock. There must not be added salt in the diet. The diet need not be salt-free but the patient must not take additional salt at the table. I am not so confident in the results of the ileal loop procedure as others seem to be.

SYMPOSIUM ON NEUROGENIC BLADDER

DR. JOHN L. EMMETT (Rochester, Minn.): I should like to acknowledge and thank two guests who will participate in this symposium: Dr. Carl Bunts, of Richmond, Virginia, who is well known to all of you; and Mr. Norman Gibbon, of Liverpool, England. Mr. Gibbon has participated in the work of Mr. Cosbie Ross and Mr. Marek Damanski and their group at the Southport Paraplegic Center. Their work, especially with pudendal-nerve section in the treatment of cord bladder, has been a distinct contribution to the subject. Dr. Reed Nesbit also was to participate in this symposium, but in his unavoidable absence Dr. Justin Cordonnier has kindly consented to read Dr. Nesbit's comments and make some informal comments concerning his own experience with the ileal spout as a method of diversion of urine in children who have myelodysplasia and spina bifida.

The symposium will be divided into two parts, based on the causation of the neurologic lesion, namely 1) acquired and 2) congenital. This division has been made for a special reason, for although many factors are common to both types, *one factor sets them widely apart, so far as treatment is concerned.* That is, when a lower-motor-neuron lesion is present *in acquired cord bladder*, a satisfactorily continent bladder may be expected to result from proper treatment in a high percentage of cases. On the other hand, all too often an apparently similar situation when a *congenital lesion* is present (such as spina bifida and myelodysplasia) cannot be successfully treated because of passive continuous incontinence, even after residual urine has been eliminated by conservative measures or operation on the vesical neck.[1-3]

The cause of this apparent paradox has not been too clear. Yet I think a reasonable explanation for this difference in results may be that when the congenital lesions are present, the external sphincter muscle never has developed normally because of an inadequate nerve supply. This is in contradistinction to the situation in acquired lesions, when a normal sphincter muscle is present, even though its nerve supply has been impaired.

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SPINAL CORD INJURY: EARLY UROLOGICAL TREATMENT

GEORGE C. PRATHER

The urological program immediately following spinal cord injury is somewhat standardized at present and I offer nothing new. The time period covered by my paper, as per agreement with our moderator Dr. Emmett, begins within twelve hours after injury and continues for at least six months in those who have a severe injury. The procedures which are not infrequently required for ultimate optimum rehabilitation at a later period of recovery will be described by others in this symposium.

It is during the early period after spinal cord injury that we endeavor to protect the urinary tract from complications and thus try to facilitate maximum physiological recovery. In our efforts to protect the urinary apparatus from conditions prone to those incapacitated by paralysis, and from errors or accidents which can so easily be produced by misunderstanding the principles and techniques involved, we naturally should think of the whole urinary tract. We should strive to prevent stone formation and infection in the kidneys. We should be aware of vesicoureteral reflux if it is present in order to avoid any form of bladder program that might contribute to renal woes. We should care for the bladder in a manner which will attempt to avoid stone formation, intramural infection or adverse change in capacity. We should take every possible precaution to prevent urethral complications which delay maximum recovery. Thus, each and every time we see our paraplegic patient we try to visualize the status and condition of the whole urinary tract, even though at times it seems impossible to understand the details of the various physiological processes which are taking place or fail to take place.

Now, to transfer from the idealistic picture to the practical program; our immediate objective is to place the bladder on drainage and obtain certain base line data as soon as the general condition of the patient permits.

A 16F soft rubber balloon catheter seems best in size and type for the average adult. After sterile catheterization, in order to empty all of the urine from the bladder, the catheter can be connected to a sterile closed drainage and irrigation system to permit periodic manual irrigation of the bladder every four hours, using 100–150 cc physiological saline solution for an irrigating medium. This will produce a cleansing action and after a fashion simulate at least a transient, partial distention of the bladder. Why saline as an irrigating solution? It is nonirritating and I do not know of a better medium for routine use.

Shortly one can consider the desirability of some form of tidal drainage. If proper equipment and proper personnel are at hand I believe the automatic system may be used with satisfaction, although personally I have never been convinced that true tidal drainage is necessarily contributory toward maximum recovery of bladder function.

If it is necessary to devise some type of tidal apparatus and if the attendants

are not familiar with the intricacies and caprices of this system, I deem it far safer to rely on the simple closed system with manual control of irrigation.

Certainly in civilian life, one should not go directly to suprapubic cystotomy. The extent of the spinal cord injury cannot be immediately foretold. The patient may have considerable systemic shock. There may be considerable abdominal distention from ileus. The neurosurgeon may be busy with spinal punctures or surgical procedures. A catheter will drain the urine effectively and a clean bladder can be maintained without the additional risk of a surgical procedure.

Although now well known, it seems wise to stress the use of a soft and small urethral catheter. Just as pressure on the skin over bony prominences of a paralyzed person quickly leads to necrosis in that area, a too large or a too rigid catheter no doubt will contribute to pressure necrosis at the penoscrotal angle, a periurethral abscess, urethral fistula and perhaps urethral diverticulum. If the proponents of catheter drainage in the paraplegic patient are to win over those who favor suprapubic drainage, urethral and scrotal sepsis must be kept at a very low incidence. Great care with sterility at the time of catheterization or change of catheters, and the smallness and softness of the catheter will help to avoid distressing complications.

One often reads "the catheter should be changed every seven to ten days." That may be good advice if there is a tendency toward encrustation. However, I prefer individual consideration of said catheter, leaving it in place as long as it appears to drain and irrigate efficiently. If a catheter will function properly for two to three weeks, let us avoid more frequent manipulation. Should a catheter be left in place without changing for longer than perhaps three weeks? Probably not, because of the tendency for eggshell-like stone deposit to form on the outside of the balloon part of the catheter in some individuals.

Let us assume that the patient has survived the initial stress and shock of his accident and that a few weeks have gone by. It is time now to think of obtaining base line data in regard to the urinary tract, information which will be extremely helpful in the diagnosis and treatment of problems in the future.

Information most desired is: degree of tone and extent of detrusor activity if present, presence or absence of ureterovesical reflux, and the status of the upper urinary tract.

The much debated cystometric determination needs discussion. All will agree that individual determinations can be difficult to explain or classify and yet it is probably our best method of estimating the presence or absence of detrusor activity and tone. The examination will not tell the examiner which patient will be able to void because there are other factors in the region of the bladder neck and external sphincter muscle which have importance in the act of urination. However, the test should indicate which bladders have a chance of performing with reasonable efficiency if obstructive elements are not an impediment.

Cystometrograms—serial in a sense—done by the same person and with the same technique every two to three weeks are likely to be more informative than one single examination. It is the change or evidence of return of detrusor activity which leads to encouragement and elation. Likewise continued hypotonicity

indicates that immediate rehabilitation may not be at hand. Therefore, let us stress periodic cystometrograms as important documents in the program for proper care of the paraplegic bladder.

In performing cystometric study, I prefer the constant drip (about 100 drops per minute) water manometer type of study. The examiner, constantly observing the level and variations in the manometer during the test and watching the patient as a whole, has a far better idea of bladder action than the one who simply reviews a recording or a chart made by someone else. Likewise a constant drip filling of the bladder will be more physiological than adding fluid by 50 cc increments.

Base line information concerning the question of ureterovesical reflux and the anatomical condition of the upper urinary tract can be obtained on one trip to the x-ray department. Following a plain film of the urinary tract a cystogram is done, using a volume of opaque medium to the point of reflex activity of the bladder if detrusor activity is present or up to 300 cc if the bladder is hypotonic. These films will demonstrate reflux up the ureters if it is present. After the cystographic medium has been emptied from the bladder, an intravenous urogram can be done for delineation of the upper urinary tract.

Thus, in the first few weeks after spinal cord injury, basic data pertaining to the urinary tract have been obtained. This information will be valuable to compare with the findings at subsequent examinations.

Because infection and stone formation in the urinary tract are two major hazards in the life of the paraplegic patient, what can we do to keep these complications at a minimum?

Let us mention urinary tract infection first. I believe that it is impossible to keep the bladder bacteria free with a catheter in place. A thick purulent urinary condition can usually be avoided however by diligent care of the tidal or manual irrigations of the bladder.

We wish to avoid renal infection if possible or avoid major involvement if present. There are many points of view as to the best way to accomplish this—none of them probably infallible. The following is a personal opinion in regard to the program which will cover some months. Firstly, I would not use sulfonamide or antibiotic medication as a routine prophylactic measure as long as there are no clinical indications of pyelonephritis. If a febrile episode develops which appears to be caused by renal infection, I would suggest a broad spectrum antibiotic without delay for at least a week. If response to this medication has been satisfactory it would then seem reasonable to use a daily maintenance dose (usually one quarter to one half the routine daily quantity for acute pyelonephritis) of either an antibiotic or sulfonamide for an indefinite period. Experience with this type of program has seemed to permit an afebrile course over a long period more effectively than a plan in which all medication is stopped when an acute episode appears to be over. While it is true that further febrile periods of renal infection may develop at which time full dosage therapy may be required, I favor a continued maintenance policy in the paraplegic or others who seem to be prone to pyelonephritis.

Our next consideration is the threat of stone formation in the kidneys. Known prophylactic measures are: firstly, frequent changes in body positions and early ambulation and secondly, a large daily urinary output.

The dietary regimen is difficult to evaluate as it relates to stone formation, but the paraplegic patient sometimes has serious over-all metabolic problems which must be seriously considered without regard for the urinary tract. Measures need to be taken to minimize the wasting of body tissue. All essential nutrients are required with emphasis on proteins and a high total caloric intake. Thus the general problem of nutrition takes precedence over any possible effect on urinary stone formation. Aluminum gels will add to the difficulties of a sluggish intestinal tract. Daily intake of salicylates is yet to be finally evaluated in the role of a stone deterrent.

Thus, a brief outline of a program for the care of the urinary tract during the early stages of recovery following spinal cord injury has been presented. My comments represent personal opinion, not universal agreement. Future progress in this field will be received with heartfelt thanks both by the patient and the urologist. I look forward to other papers in this symposium which deal with the problems of late or definitive rehabilitation of the urinary tract.

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TREATMENT OF THE CHRONIC PHASE OF CORD BLADDER

JOHN L. EMMETT

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I propose to discuss the management of patients in whom acceptable function of the bladder has not developed as a result of conservative treatment and education in respect to the bladder as outlined by Dr. Prather. Mr. Gibbon tells me that approximately 25 per cent of the paraplegic patients on the service at Southport Paraplegic Center are of this group. Talbot suggested the same figure. Comarr (1957) was more pessimistic. He reported that of 180 paraplegic patients only 36 (20 per cent) became catheter-free as a result of conservative treatment with either straight or tidal drainage and training of the bladder. At any rate, we all know that there are plenty of patients in this category who need help. This discussion will not be limited to traumatic paraplegia, but will also include "medical" lesions of the central nervous system which confront the urologist in private practice.

The three main problems of the chronic phase of cord bladder are 1) persistence of substantial amounts of residual urine, 2) lack of socially acceptable urinary control, and 3) vesicoureteral reflux, with deterioration of the upper part of the urinary tract (which occurs in 25 to 50 per cent of paraplegic persons). I shall briefly discuss the first two. Dr. Bunts will discuss the third.

LOWER MOTOR NEURON LESIONS

Broadly speaking, the so-called spastic urinary tract of the *upper motor neuron lesion* causes the most trouble. The so-called flaccid urinary tract of the *lower motor neuron lesion* gives the least trouble and is more amenable to treatment. As a dramatic example of the latter statement, I refer you to the published experiences of Dr. Collin S. MacCarty concerning "selective cordectomy." For the purpose of eliminating severe disabling contractures of the lower extremities in completely paraplegic persons who had lesions in the middle or high thoracic part of the spinal cord which made nursing care difficult, he removed the entire cord below the level of the lesion. This of course converted the condition from an upper to a lower motor neuron lesion. The postoperative urologic status of those patients was interesting. Most had very satisfactory vesical function. They were able to void at will every three to five hours with abdominal straining or manual Credé expression, or both; they could empty the bladder completely and with little or no leakage of urine between voidings, unless they were engaging in some strenuous exercise involving marked straining with a moderately full bladder. In a few cases, transurethral resection of the vesical neck was necessary to accomplish this result.

How does one explain this satisfactory vesical function? Apparently, the denervated external sphincter and vesical neck have enough passive resistance to prevent leakage of urine—and yet are weak enough to allow complete evacuation of urine with straining and manual Credé expression. It is now generally agreed

that the cord bladder of the lower motor neuron lesion lies exclusively in the province of transurethral resection. Nerve blocks and sections are not indicated, for all nerves serving vesical function should be paralyzed (except in unusual cases in which "spotty"—mixed—or incomplete lesions are present). When necessary, transurethral resection should give good results in a high percentage of cases. So far as this paper is concerned, it should be remembered that we are using Bors' criteria to prove a lower motor neuron lesion, namely, a relaxed anal sphincter and absent bulbocavernosus and anal reflexes.

UPPER MOTOR NEURON LESIONS

Let us now turn our attention to the so-called spastic urinary tract of the upper motor neuron lesion. Spasticity (and accompanying hypertrophy) may involve any or all of the following structures 1) detrusor musculature, 2) vesical neck, 3) prostatic urethra, and 4) the external urethral sphincter. What is the cause of this spasticity? *In the (striated) external sphincter* it is the typical response of striated muscle to an upper motor neuron lesion and can, of course, vary in degree of severity. *In the presence of involvement of the detrusor musculature, vesical neck, and prostatic urethra,* the smooth-muscle component of these structures apparently is affected by abnormal, pathologic stimuli originating in the sacral part of the spinal cord which probably result from lack of control of higher centers. Moreover, these impulses may be "aided and abetted" and increased in frequency and irregularity by reflex stimulation from spastic muscles of the perineum and lower extremities.

There is still another factor involved. It has been shown clinically by Bors and associates and anatomically by Beneventi and Marshall that striated muscle fibers arising from the external sphincter are intertwined with the smooth muscle of the prostatic urethra and vesical neck (especially the anterior half). These striated muscle fibers of course would take part in the spasticity, for the same reason as that given for the external sphincter.

TREATMENT

The chief aim in treatment is to reduce or to eliminate spasticity and hypertonicity of the detrusor musculature, vesical neck, prostatic urethra and external urethral sphincter. Therapeutic procedures which are available include 1) transurethral resection (of both the vesical neck and prostatic urethra), 2) nerve sectioning (section of the pudendal nerve and Meirowsky's differential sacral neurotomy), 3) subarachnoid injection of alcohol (Sheldon and Bors) or selective cordectomy (MacCarty) and 4) denervation of the bladder by section of the pelvic nerves (nervi erigentes) as described by Leadbetter and Shaffer (1955). These various procedures should be considered complementary rather than competitive. For instance, a combination of transurethral resection and nerve block often will accomplish better results than either procedure used alone.

How can one decide which procedure to use in a given case? The first step in making such a decision is to analyze just what each procedure can be expected to accomplish. Let us briefly consider each procedure from this point of view.

Subarachnoid injection of alcohol; selective cordectomy. These are "radical" procedures which will completely convert an upper motor neuron lesion to a lower motor neuron lesion (including production of complete, flaccid paralysis of the lower extremities). The procedures of course would be used only in the presence of complete, permanent lesions in which there is no hope of recovery for the cord, and usually as a last resort when other procedures have failed. These procedures are especially indicated for patients who have troublesome spastic contractures of the lower extremities which greatly complicate nursing care. As previously mentioned under the heading of "lower motor neuron lesions," transurethral resection also will be necessary in some cases, depending upon the degree of muscular hypertrophy or fibrosis which has developed at the vesical neck or in the prostatic urethra. Associated prostatic hyperplasia also could serve as an indication.

Denervation of the bladder (section of pelvic nerves—nervi erigentes). As yet denervation of the bladder is not a standardized surgical procedure (Leadbetter and Shaffer), so that evaluation is not yet possible. If it can be accurately executed, the operation should relieve spasticity of the detrusor musculature and of the smooth-muscle components of the vesical neck and prostatic urethra.

Bilateral section of pudendal nerves. This procedure was developed by Bors. Cosbie Ross and his group in Liverpool now have by far the greatest experience with it. It can be used for either complete or incomplete lesions because the resultant paralysis of the perineal muscles and anal sphincter is not too troublesome to the patient. Bilateral sectioning of the pudendal nerves can be expected to produce 1) *certain* relaxation of the spastic external urethral sphincter, 2) *possible* relaxation of the vesical neck and prostatic urethra of varying degrees, depending on the proportion of striated muscle fibers present in these structures, and 3) *possible* reduction in spasticity of the detrusor musculature if reflex activity from spastic muscles of the perineum is a contributing factor in stimulating an irritable sacral portion of the spinal cord.

Meirowsky's differential sacral neurotomy. Theoretically, this is an interesting approach because it can be considered as a sort of "titration procedure," enabling the surgeon to cut just the right proportion of sacral root fibers (carrying both somatic and parasympathetic fibers) to restore normal "balance" to the bladder and its sphincters. (For example, it is possible to cut the fibers of only the third sacral nerve roots or various combinations, such as the third and fourth sacral nerve roots and so on). This procedure can be used when complete lesions are present and also when incomplete lesions are at hand, if caution is used to avoid excessive weakening of the muscles of the buttocks, thighs, legs and feet which are partially innervated by sacral nerve roots. The segmental distribution of motor fibers of the lumbar and sacral nerves is shown in figure 1. It must be realized, however, that this distribution varies greatly in individual cases. Generally speaking, the fibers of the third, fourth and fifth sacral nerve roots usually can be cut without serious disability. If the second sacral nerve roots are cut, detectable weakness will ensue. If the first sacral nerve roots are cut, considerable weakness will follow. The safest procedure, however, is to estimate this

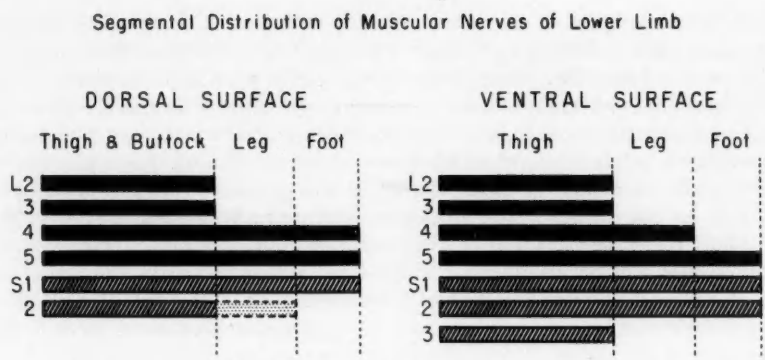

FIG. 1. Segmental distribution of motor fibers of lumbar and sacral nerves

weakness before sectioning, by means of anesthetic blocks of the roots being considered for sectioning.

What can differential sacral root neurotomy be expected to accomplish? It should be possible to obtain varying degrees of relaxation of the external urethral sphincter, vesical neck, prostatic urethra and detrusor musculature from relaxation of both striated and smooth muscle fibers, as explained above.

Transurethral resection. Transurethral resection should be able to relax both the vesical neck and prostatic urethra by removing both smooth and striated muscle fibers making up these structures, as well as any organic hypertrophy, fibrosis, or prostatic hyperplasia present. This procedure is especially important against long-standing lesions which have caused muscular hypertrophy and fibrosis. The operation also is especially applicable in the presence of nontraumatic neurologic lesions in men in middle and late life when varying degrees of prostatic hyperplasia are present.

PREDICTING RESULTS OF NERVE SECTIONS, SUBARACHNOID INJECTION OF ALCOHOL AND THE LIKE

Fortunately, it is possible to predict with reasonable accuracy the results of nerve sections, alcohol block, selective cordectomy and so on, by prior simulation of the procedure by means of anesthetic blocks. For instance, the subarachnoid injection of alcohol or selective cordectomy can be simulated by spinal anesthesia; section of the pudendal nerves by pudendal anesthetic block and differential sacral neurotomy by differential transsacral block. Unfortunately, there is no diagnostic procedure to predict the results of transurethral resection.

The results of diagnostic nerve blocks are evaluated in the following manner. First, a urethrogram (either retrograde or one made at voiding) is made both before and after the block (while the anesthesia is still in effect). The degree of tonicity of the external sphincter is easily demonstrated (fig. 2). The degree of spasticity and relaxation of the prostatic urethra and vesical neck is more difficult to evaluate (Damanski and Kerr).

Second, the patient's ability to void both before and after block is noted by

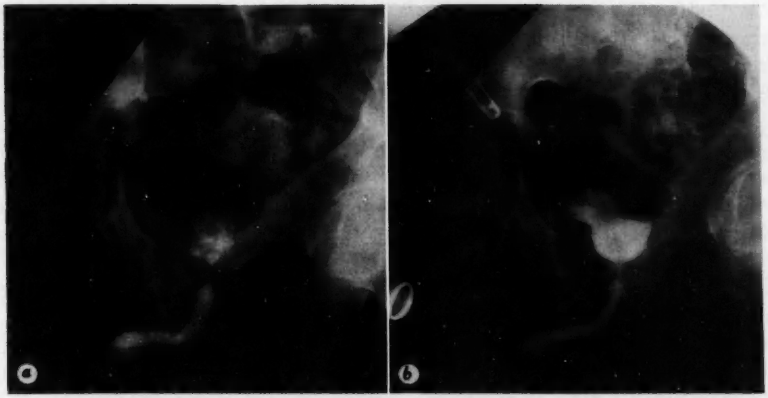

FIG. 2. Urethrogram indicating spasticity. *A*, before block. *B*, after block. (Reproduced, with permission of the publishers, from: Emmett, J. L., Daut, R. V. and Dunn, J. H.: Role of the external urethral sphincter in the normal bladder and cord bladder. J. Urol., **59**: 439–454, 1948.)

filling the bladder with fluid and requesting the patient to void by means of abdominal straining or manual Credé expression or both. His ability to stop urination and the presence or absence of leakage while at rest are noted.

Third, and finally, the vesical capacity and the amount of residual urine before and after blocking are determined.

Other observations which also may be helpful, although they are more of academic interest, include cystometrograms and sphincter metrograms made before and after the anesthetic block.

HOW TO CHOOSE THERAPEUTIC PROCEDURES

When therapeutic procedures are to be chosen in a given case, certain general principles must be kept in mind. First, it should be remembered that nerve sectionings are destructive as well as final procedures that cannot be reversed. The nerves cannot be joined together again. On the other hand, transurethral resection is not a destructive procedure; no harm is done, no bridges have been burned, so to speak, and no complicating factor has been introduced, even if the procedure proves to be ineffectual.

In the case of *complete permanent lesions*, no harm is done by nerve sectioning, alcohol block, cordectomy and so on, hence these procedures can be used more or less without hesitation, if diagnostic studies carried out with preliminary blocks suggest they will give good results. In *incomplete lesions* the situation is much different, so that the various nerve blocks must be carefully considered to avoid results which might make the patient's general condition worse, increasing his disability and need for nursing care. Generally speaking, when incomplete lesions are present, or when so-called medical lesions of the cord are at hand (and especially if the patient is a man past 40 years of age), my feeling is that transurethral resection should be tried first, and repeated if necessary. If it fails, then the various types of sectioning should be considered.

RESULTS OF SURGICAL PROCEDURES

A question frequently asked is, What results can be expected from these various procedures? It is difficult to answer this question with any degree of accuracy, but the following data may be helpful in forming some general conclusions.

Sectioning of pudendal nerves. Bors and Comarr (1954) wrote that they had used operations on the pudendal nerves (either neurotripsy or sectioning) for approximately 3 per cent, and transurethral resection for approximately 20 per cent, of 844 paraplegic persons. Twenty-nine patients had undergone pudendal-nerve operations (either neurotripsy or sectioning). Of the 29, 11 had been treated by pudendal-nerve operation only, and 18 had undergone a combination of pudendal-nerve operation and transurethral resection. Approximately three fourths of each group had regained "balanced function of the bladder."

Cosbie Ross (1956) reported the results of 29 bilateral pudendal-nerve sectioning. (Mr. Gibbon tells me that they have now done almost double that number.) For 27 of the patients the sectionings were successful, as proved by Bors' criteria of relaxed anal sphincter and absent bulbocavernosus and anal reflexes. Of these 27 patients, 19 (70 per cent) achieved good results, as evidenced by a dramatic reduction in the amount of residual urine. Among the 8 patients for whom the operation was a failure, ultimate success was achieved for six by means of transurethral resection (three) and subarachnoid injection of alcohol (three).

Differential sacral neurotomy. Meirowsky tested 115 paraplegic patients and found 18 suitable for this procedure. Among the 18 he obtained good results for 13 (approximately three fourths).

Transurethral resection. Results obtained from transurethral resection vary greatly in different hands, apparently because of the great variations in the completeness of the operation. Some workers remove only a few pieces of tissue from the posterior vesical lip. At the Mayo Clinic it has always been our policy to resect the entire circumference of the vesical neck. We have found that it is not a simple procedure to neutralize completely the muscular activity of the vesical neck (and the prostatic urethra in the male). It often requires multiple operations and the removal of comparatively large amounts of tissue to accomplish this objective. Our previous statistics (Emmett, Albers, and Anderson, 1951) are hardly applicable here, because the cases were not divided into those of upper motor neuron lesions and lower motor neuron lesions on the basis of Bors' criteria (relaxed anal sphincter and absent bulbocavernosus and anal reflexes). For the group as a whole, we felt we were able to expect good results in approximately one of three complete lesions and two of three incomplete lesions. We observed that the patients who had "low lesions" in which abdominal muscles were intact, and the bladder appeared to be of the nonreflex (antonomous) type, could expect by far the best results from transurethral resection.

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MANAGEMENT OF UROLOGICAL COMPLICATIONS IN 1000 PARAPLEGICS

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A great number of surgical procedures are necessary in the care of the complications which are a direct or indirect result of paraplegia.

This study of the incidence and surgical management of genitourinary tract complications in 1000 paraplegics who have been under our care for the past 11 years was made primarily to determine whether or not our methods of treatment have resulted in a decrease in the number and severity of these complications. The number and type of surgical procedures used in the treatment of these complications are tabulated as follows:

SURGERY FOR UPPER URINARY TRACT COMPLICATIONS

Renal and ureteral calculi. Although the surgical principles for the management of upper urinary tract calculi are the same in the paraplegic as the nonparaplegic, several points should be emphasized in applying these principles in the paralyzed patient. Since symptoms are rarely present one must depend upon the routine use of excretory urography in the paraplegic who has an elevation of temperature of undetermined origin. Surgery for the removal of renal or ureteral calculi not causing obstruction should be postponed until the patient is no longer confined to his bed.

There is a definite increase in incidence of calculi in those patients with low cervical or high thoracic lesions where ambulation is delayed. Hypercalcemia, present to some degree in the first few months in all paraplegics, also plays a part in the production of calculi but is probably only incidental, and without the presence of stasis and infection would not be of major importance. Infection may be combated by forcing fluids and intermittent chemotherapy and antibiotics. Early ambulation should be accomplished as soon as possible.

Comment: It will be noted in the graph (fig. 1) that 57 patients, 5.7 per cent, among 1000 paraplegics acquired renal or ureteral calculi. Forty-two were renal and 15 ureteral calculi. Nine were bilateral and 48 unilateral.

As shown by the graph, 20 patients required multiple procedures. Two patients had four procedures; three, 3; and fifteen, 2 operations for removal of calculi. We believe that only two patients had true recurrences and in nine "recurrence" was the result of the incomplete removal of calculi at the time of the previous operation. In the remaining nine patients the calculi were bilateral, present either in the opposite kidney or ureter.

Admittedly, these were a large number of repeat operations for the removal of calculi. We believe it is of utmost importance to conserve renal tissue. Only 1 patient of this series required nephrectomy. Three of the 57 patients have died in the past 11 years. Two are listed as dying from calculous pyonephrosis. One died with adrenal insufficiency the second day following surgery.

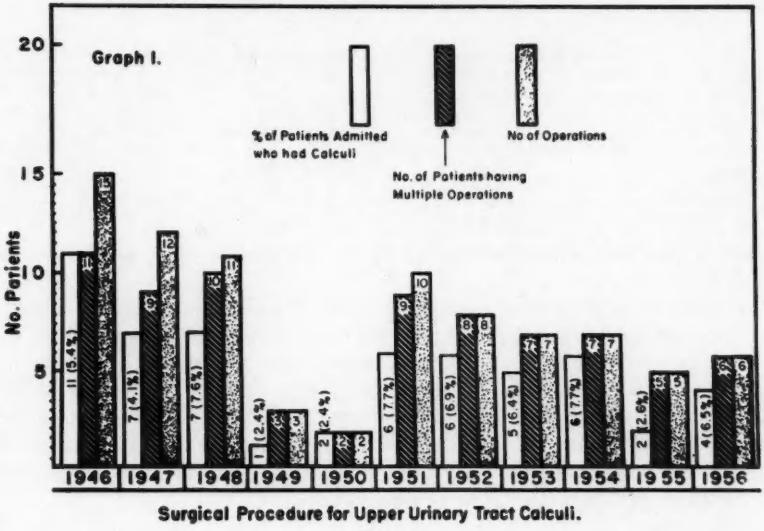

FIG. 1

It will be noted that for the first 3 years following World War II, a large number of patients had calculi that required surgery. The rate declined until 1951 at which time we began receiving the Korean War veterans. Again there was slight increase in the incidence which has slowly decreased and has remained stable for the past 4 years.

Two important findings may be noted: First, most of the stones form within the first 12–36 months following cord injury; and secondly, although not shown on the graph, the incidence of calculi in our series has been in direct proportion to the number of new cases admitted, varying from 2.5 per cent of 40 patients admitted in 1949 to 7.8 per cent of 79 patients admitted in 1951. Of 612 patients who entered the hospital prior to 1951, 4.7 per cent acquired calculi and 6.7 per cent of 488 have been treated for calculi subsequent to the onset of the Korean War. These figures vary widely from those where the total number of patients occupying beds at any given time is the basis for the compilation.

We were somewhat surprised with our findings of a rather stable percentage ratio of patients who developed calculi over the past 11 years. But when our methods for prevention of calculi were analyzed it was noted that our methods had changed very little, if at all. Also, the great majority were admitted to our hospital several months following injury.

Nephrostomy drainage. Nephrostomy drainage, to preserve the failing function of damaged kidneys or as a means of drainage following nephrolithotomy, was performed 36 times on 27 patients. Twenty had operations for pyelectasis resulting from vesicoureteral reflux, one for obstruction following vesicoureteral plasty, one for destruction of the upper ureter by gunshot, and five for pyelectasis due to calculi. Seven of these patients are now dead from renal insufficiency.

TABLE 1. *Incidence of nephrostomy drainage*

	Year											Total
	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	
No. patients	0	7	6	2	4	3	2	0	2	1	0	27
No. operations	0	9	9	3	5	5	2	0	2	1	0	36

Of these, four had vesicoureteral reflux, two had reflux plus calculi and one, calculi alone.

Comment: It will be noted from table 1 that 19 patients required 26 nephrostomies before 1950. The majority of these were carried out for pyelectasis due to vesicoureteral reflux. Since 1950, at which time we began treating vesicoureteral reflux by plastic repair of the vesicoureteral junction, only eight patients have required nephrostomy. Two of these were carried out preliminary to plastic repair of the vesicoureteral junction and one to afford drainage for obstruction of the ureter subsequent to vesicoureteral plasty. The remaining five patients had nephrostomy drainage following removal of calculi.

Complications requiring nephrectomy. As stated before, the conservation of renal tissue in the paraplegic is of prime importance. Nephrectomy has only been necessary in five of the 1000 patients, all were for pyohydronephrosis. Calculi were present in two of the five patients.

Complications requiring skin ureterostomy. Only two patients have had a total of three skin ureterostomies. One patient with severe spinal arthritis required bilateral skin ureterostomy following recurrence of renal calculi. The second patient with a single kidney required skin ureterostomy for a megaloureter and pyelectasis due to reflux.

Complications requiring vesicoureteral plasty. Since April 1946, 136 (13.6 per cent) of the 1000 patients who have been admitted to our Paraplegic Service have had reflux of clinical significance. In 1950 we began to concentrate our attack directly on the vesicoureteral junction for the treatment of vesicoureteral reflux. It is our opinion that reflux in these patients is the result of anatomical changes in or near the vesicoureteral opening. These changes are indirectly associated with cord injury and probably result from erratic impulses originating in the distal stump of the cord, causing the bladder to become trabeculated and contracted. The complications that accompany cord injury such as bladder stones, prolonged cystitis and the ever present foreign body (catheter or suprapubic tube) are probably also factors in the development of reflux in the paraplegic.

After several unsuccessful attempts to alleviate reflux by simple reimplantation of the ureter, an operative procedure was devised at our hospital which has three principles. First, the attachment of the ureter to the trigone is preserved; second, a long intravesical ureter is constructed; and third, the bladder wall behind the ureter is reinforced.

To date this procedure has been performed in those patients in whom the reflux did not disappear under routine catheter drainage (20 per cent in our

TABLE 2. *Incidence and results of vesicoureteral plasty*

Year	Patients	Ureters	Success	Failure	Obstruction	Reflux
1950	5	6	5	1	0	1
1951	8	14	11	3	0	3
1952	3	5	5	0	0	0
1953	3	5	2	3	1	2
1954	3	5	4	1	0	1
1955	6	11	8	3	2	1
1956	3	5	3	2	2	0
Total.....	31	51	38	13	5	8

patients). These patients for the most part had a mild reflux without evidence of irreversible anatomical changes in or near the ureteral orifice. Our indications and criteria for surgical correction of reflux are: 1) X-ray evidence of damage to the upper urinary tract. 2) In the absence of upper urinary tract damage, as depicted by x-ray, repeated attacks of pyelonephritis serve as an indication. 3) The reflux should be permanent and irreversible as shown by cystoscopic inspection and repeated cystograms at monthly intervals of at least three months.

Comment: Since 1950, vesicoureteral plasty has been carried out on 31 patients and 51 ureters (table 2). Thirty-eight of these were successful, our criteria for a good result being: first, no reflux present; second, same or improved pyelograms; and third, clinical improvement. Thirteen procedures were failures, eight being due to recurrence of reflux and five to obstruction at the site of operation. The early recurrences of reflux and postoperative obstruction are due to faulty surgical technique. Late recurring reflux results from failure to eliminate the etiologic basis for the reflux. One death occurred in this series five days following operation due to a fulminating pyelonephritis.

It will be noted in table 2 that a fairly even number of patients throughout the past 7 years have required vesicoureteral plasty for reflux. We cannot expect a marked decrease in the number of paraplegic patients who acquire reflux inasmuch as a definite percentage who have spastic hypertonic bladders will acquire anatomical changes near the ureterovesical junction that will produce reflux.

Suprapubic cystostomy. Cystostomy is indicated whenever drainage of the bladder by urethral catheter is impractical. Lack of facilities for close observation and nursing care is the most common reason for its use. Other indications are incontinence in the female, periurethritis, periurethral abscesses and recurrent epididymitis.

Comment: The majority of the cystostomies shown in table 3 were carried

TABLE 3. *Incidence of cystostomy drainage*

	Year										Total
	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	
No. operations.....	1	0	2	3	4	7	3	2	1	3	1	27

out on those quadriplegics in whom a satisfactory reflex bladder failed to develop. Several had cystostomy drainage preliminary to repair of urethral fistula and diverticulum. Four required cystostomy for removal of large bladder calculi. It is apparent from table 3 that cystostomy drainage as a means of diversion has not been used by us routinely. It is our opinion that the bladder is not allowed to act as a single physiologic functioning unit when there is a break in the continuity of the bladder musculature produced by cystostomy. Rehabilitation is prolonged, as extra time is required for healing of the suprapubic fistula. In most patients who have prolonged cystostomy drainage it is necessary to increase the capacity of the bladder following discontinuance of drainage.

In a survey made by us in which we compared the end results of bladder function following urethral or cystostomy drainage, we noted that poorly functioning bladders were found more often and vesicoureteral reflux was present in a higher percentage of the patients who had drainage by cystostomy. The most serious complication resulting from cystostomy drainage is discussed below.

Surgical closure of suprapubic fistula. Cystostomy wounds fail to close in some patients primarily because they have been improperly performed, the tract having been established too close to the symphysis pubis. Other factors that may be present are the development of a fibrotic epithelized tract; the presence of infection at all times; and a "neurogenic factor" coupled with a diminution in tonicity of the abdominal musculature. The seriousness of this complication was manifested to us when the postmortem examination in three deaths on our service showed that only the distal portion of the sinus had healed and the unhealed fibrotic barrier of the unobliterated juxtavesical portion was overcome. This resulted in fatal peritonitis by direct contiguity in two patients, and by direct rupture into the peritoneal cavity in the third.

Comment: It will be noted in table 4 that the majority of cystostomy closures were necessary immediately following World War II followed by a decline in number until 1951 near the end of the Korean War. Not until the latter months of World War II, when transportation of all casualities by air was accomplished, was it possible to use urethral drainage. Also, the general surgical personnel probably had not been instructed as to the correct method of performing cystostomy. This resulted in many suprapubic tubes being brought out just above the symphysis pubis. Our findings since 1952 show that either cystostomy as a means of drainage has been abandoned by many or when resorted to, has been properly performed.

Transurethral resection of the bladder neck. Resection of the hypertrophied or spastic bladder neck is undoubtedly the best single means of converting an unbalanced to a balanced neurogenic bladder. It is well recognized that there is a

TABLE 4. *Incidence of closure of suprapubic fistula*

	Year											Total
	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	
No. operations	25	9	8	7	5	10	0	0	0	3	0	67

TABLE 5. *Number of transurethral resections of bladder neck*

	Year											Total
	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	
No. operations	8	5	30	22	26	28	24	28	27	21	19	239

TABLE 6. *Number of transurethral resections on 188 patients*

No. Tur's	No. Patients	% Patients	Total No. Tur's
1	150	63.1	150
2	26	21.8	53
3	11	13.8	33
4	1	1.3	4
Totals	188	100%	239

balance of power existing between opposite forces, namely the detrusor for expelling the urine and the obstructive sphincteric mechanism of the internal orifice and rarely the external urethral sphincter. Although there is a difference of opinion as to the presence of a true mechanical obstruction, there can be little doubt that a high percentage of patients are benefited by resection whether it be due to the removal of true hypertrophied tissue or elimination of spasm of the internal orifice.

Comment: From tables 5 and 6 we note that 188 or 18.8 per cent of 1000 paraplegics had transurethral resection. Thirty-eight patients required multiple procedures. This is a smaller number of multiple procedures than reported by others. We are of the opinion that the resection should include the entire circumference of the bladder neck with resection of all tissue back to the verumontanum, as removal of the bladder neck alone may result in obstruction from a minimal amount of tissue near the veru which is made prominent by resection of the bladder neck.

We believe that transurethral resection should be postponed if possible until all conservative methods for bringing the bladder into balance have been attempted. During the years 1946 and 1947 only 13 patients had resections. If possible we wait at least one year before resorting to resection. Eighty-five per cent of our patients had good or fair results. There were no postoperative deaths. Bleeding was rarely troublesome. There has been very little yearly change in the number of resections considered necessary over the past nine years (1948–1956).

Surgery for bladder calculi. Bladder calculi are of frequent occurrence in the paraplegic. It is our estimate that at least 50 per cent of our patients have at one time had calculi, usually of the "eggshell" variety. It has been necessary in only four instances to remove these calculi by a suprapubic procedure. The eggshell type are readily removed by the Ellik evacuator or the Lowsley grasping forceps. During the past year we have placed a group of patients on salicylamide and these patients have rarely acquired bladder calculi.

TABLE 7. *Number of fistulas and diverticula repaired*

	Year										Total
	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	
No. fistulas	14	11	15	15	12	12	10	4	3	7	3	106
No. diverticula	1	0	5	10	3	5	11	2	2	3	3	46

TABLE 8. *Number of procedures required to repair fistulas in 67 patients and diverticula in 41 patients*

Fistulas

No. of Fistulas Repaired	Total No. of Patients	Percentage of Patients	Total No. of Fistulas Repaired
1	45	67	45
2	12	18	24
3	6	9	18
4	2	3	8
5	1	1.5	5
6	1	1.5	6
Total	67	100%	106

Diverticula

No. of Diverticula Repaired	Total No. of Patients	Percentage of Patients	Total No. of Diverticula Repaired
1	36	88	36
2	5	12	10
Total	41	100%	46

SURGERY FOR LOWER URINARY TRACT COMPLICATIONS

Urethral fistula and diverticulum. These two complications are considered together since each is a sequela to periurethral infection.

Comment: There are several interesting findings found in tables 7 and 8. Many fistulas and diverticula occurred following attempts to place these patients on urethral catheter drainage. There has been a decline in the number requiring surgery in the past 4 years. This, we believe, may be attributed to the use of small catheters and the prevention of an acute angulation of the urethra at the penoscrotal junction by taping the penis back on the lower abdomen. This reduction in the number of operative procedures is not a true index of the number of patients who acquire urethral fistulas as a much larger percentage at the present do not require surgical closure. The use of clorpactin irrigations per urethram and fistula has resulted in the prompt healing of many fistulas in the past two years. Surgery is still necessary for elimination of the well-formed diverticulum.

We are all aware of the surgical difficulties encountered in the abolition of the

TABLE 9. *Yearly number of perineal urethrostomies and repair of perineal fistula*

	Year											Total
	1946	1947	1948	1949	1950	1951	1952	1953	1954	1955	1956	
Perineal urethrostomy	0	11	14	8	3	11	9	10	9	14	10	101
Repair of perineal urethral fistula	1	0	6	10	7	8	0	4	7	4	0	47

fistulous tract in the urethra. As shown by table 8 only 45 fistulas were eliminated by one procedure. Twenty-two required a total of 61 procedures before the fistulas were finally cured. Diversion of the urinary stream is necessary in most patients before definitive surgery on a fistula or diverticulum is attempted.

Perineal urethrostomy and repair of perineal urethrostomy. Perineal urethrostomy was most often performed for urinary diversion preliminary to repair of diverticulum or fistula. Only on the rare occasion was it used for drainage.

Comment: The number of diversionary urethral procedures has remained fairly steady over the past 10 years. Here again we note the poor healing that occurs in the paraplegic's urethra. Forty-seven procedures were required to close perineal urethrostomy fistulas in 37 patients.

Epididymectomy and/or orchiectomy. As vasectomy was never carried out in these patients (this being the patients' desire), 20 per cent of the 1000 patients acquired genital infection. Twenty-eight or 2.8 per cent required epididymectomy and/or orchiectomy. This might appear as a rather high percentage. However, if one considers the more rapid rehabilitation with less damage to the bladder and upper urinary tract, this percentage is not prohibitive. Also in a study of the testicles removed at postmortem examination on 27 paraplegics, many with liver disease (failure to detoxify or metabolize the estrogens), it was found that 24 had from grade 1 to 3 atrophy of the testicles.

SUMMARY AND CONCLUSIONS

Many urological surgical procedures are necessary to treat the complications resulting from cord injury or disease and those complications that arise during rehabilitation of these patients. Six hundred twenty-three of 1000 patients had 723 urological operative procedures. These statistics do not include 500-plus cystoscopic removal of bladder calculi and 50-plus neurosurgical procedures used in the urological care of these 1000 patients.

The incidence of operative procedures for removal of calculi of the upper urinary tract in 1000 patients was 5.7 per cent. Surprisingly, this ratio has remained at an even rate over the past 11 years.

Nephrostomy drainage has been rarely necessary in the past five years. Repeated examinations and continuous observation have resulted in the early detection and correction of factors that might lead to renal destruction thus obviating the necessity of nephrostomy drainage.

Cystostomy as a means of drainage has never been practiced by us and has

been used much less frequently by others in the past five years. Also, it has been noted that cystostomy is now correctly performed in the great majority of paraplegic patients entering our hospital.

The number of patients who acquire reflux of clinical significance is 13.6 per cent. In our series 22 per cent have been irreversible and required vesicoureteral plasty. This incidence of reflux has remained stable over the past eight years and cannot be expected to change until we are able to eliminate the factors that cause reflux.

Transurethral resection of the bladder neck has been performed on 188, 18.8 per cent, of our patients. This yearly ratio has varied only slightly over the past 9 years.

There has been a decrease in the number of patients who acquire urethral fistulas and diverticula and a greater decrease in the number who require surgical correction.

The paraplegic patient withstands urological surgical procedures unusually well. There were two postoperative deaths following 723 operative procedures.

RESECTION OF THE EXTERNAL URETHRAL SPHINCTER IN THE PARAPLEGIC—PRELIMINARY REPORT

J. COSBIE ROSS, MAREK DAMANSKI AND NORMAN GIBBON

All those concerned with the treatment of paraplegia will be familiar with that hard core of cases in which retention of urine persists despite all attempts to reduce the resistance of the urethral canal. In some of these cases, the obstruction can be localized to the level of the external sphincter, and we propose to confine our attention to this group. It should be emphasised at this point that we are not referring to cases with spasticity in this region, as it has been shown in recent years that the spastic external sphincter can be dealt with by denervation, whether by subarachnoid alcohol injection or by pudendal neurectomy. It is noteworthy, however, that this denervation does not usually produce more than a mild form of stress incontinence, even when the internal sphincter has been resected. Leakage of urine is presumably prevented by the elastic pressure of the periurethral tissues. If this pressure is excessive, or if it is accompanied by angulation of the urethra, complete obstruction may result, as noted by Watkins (1936).

There is no true stricture in these cases, and even forcible dilatation is followed by only a brief period of improvement. For this reason, Donovan (1947) suggested punching out the region of the membranous urethra. He anticipated total incontinence as the price which would have to be paid for relief of the retention, and it is probable that this danger has deterred many urologists from attempting the operation. It has been performed successfully, however, at least once outside our own unit (Bors and Comarr: personal communication), and our experience, now to be related, provides further evidence of the value of the procedure, and suggests that the risk of incontinence has been exaggerated.

We have now resected the external urethral sphincter for nonspastic obstruction thirteen times in ten patients, of whom all but one (a case of advanced disseminated sclerosis) had a complete cord lesion. Four of the five quadriplegics had sustained a fracture-dislocation, and, of the paraplegics, the lesion was of traumatic origin in three. All had the following features in common:

1) Complete or almost complete retention of urine.

2) Localization of the obstruction at the level of the external sphincter, radiologically and sometimes endoscopically. (In four cases, bladder neck resection had already been performed.)

3) Absence of spasticity in the external sphincter region, as judged by the state of the anal and bulbocavernosus reflexes. (All the quadriplegics had had one or more subarachnoid alcohol blocks, and all the paraplegics had undergone pudendal neurectomy.)

4) Easy instrumentation, except perhaps for angulation of the membranous urethra. (Kollmann's dilator was used in some of these patients, with only momentary effect.)

In view of the generally poor prognosis in paraplegics without efficient bladder function (Damanski and Gibbon 1956), we thought it justifiable to attempt to

relieve the retention by resection of the external sphincter. As only two of our patients had retained spinal reflex detrusor contractions, the expulsive forces in the majority were poor, especially among the quadriplegics, and it seemed that, for successful results, the urethral resistance would have to be reduced to a minimum. We had no way of estimating the location and extent of the resection which would be required to achieve this object, and our technique was at first dictated mainly by considerations of convenience and safety. Up to date, we have thought it unwise to introduce modifications, but further experience may change our attitude.

THE OPERATION

We employ the cold punch, resecting three to five strips posterolaterally at the level of the external sphincter. This exposes open tissue spaces, and sets up considerable hemorrhage, mainly venous. Electrocoagulation is ineffectual, and we rely on the immediate insertion of a large three-way Foley catheter (F22 to 26) using a curved introducer if any resistance is met at the site of resection. Blood transfusions and an appropriate antibiotic are given routinely. In a few cases, the opportunity has been taken to resect the bladder neck also, despite its wide open appearance. If this procedure seems indicated, it should be done first, as it is unwise to prolong the operation once the external sphincter has been dealt with, on account of the risk of perineal extravasation. This occurred in one of our early cases, and at the end of the operation the scrotum was found to be greatly distended with fluid. As isotonic glycine was being used, and as the urine was relatively uninfected, reliance was placed upon simple elevation of the scrotum. Fortunately, the condition settled down rapidly without complications.

Continuous irrigation is usually employed postoperatively, and the larger catheter is replaced by a smaller one within twenty-four hours or so.

COMPLICATIONS

There have been two deaths: one patient who had gross urinary infection preoperatively succumbed to repeated secondary hemorrhage, while the other, who

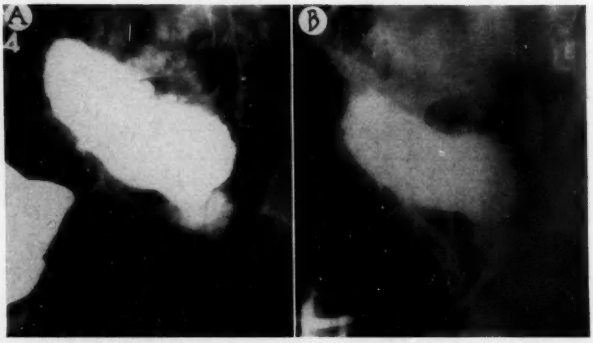

FIG. 1. Case 10, N. C. Oblique cystourethrograms. *A*, February 6, 1957, preoperatively. *B*, March 6, postoperatively.

died from uremia, was known to have bilateral ureteral reflux with hydronephrosis and poor renal function.

Apart from the fatal case, in three patients secondary hemorrhage developed, indicating the severity of their chronic urinary infection. Only in one case did late extravasation occur, and it was countered successfully by perineal drainage and suprapubic cystostomy.

RESULTS

The surviving eight cases have all been relieved of retention. In three patients, the resection had to be repeated before a satisfactory result was obtained. In one of these, perineal division of the external sphincter had been tried without success.

1) *Residual urine*. This was reduced to nil in five cases and to six to eight ounces in the others.

2) *Cystourethrography*. Radiological improvement in the caliber of the membranous urethra was marked in four cases (figs. 1 and 2), moderate in one, and doubtful or absent in the remainder.

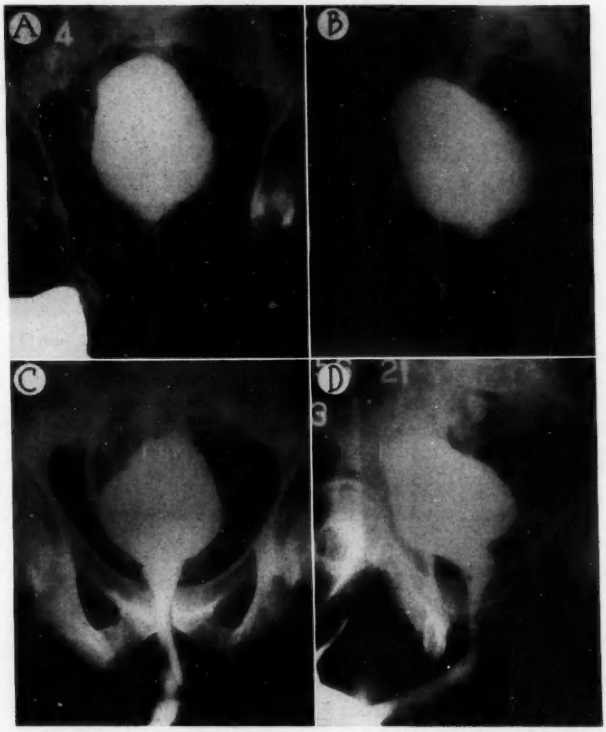

FIG. 2. Case 8, T. N. *A*, February 8, 1956, preoperative anteroposterior cystourethrogram. *B*, February 8, preoperative oblique cystourethrogram. *C*, April 4, postoperative anteroposterior cystourethrogram. *D*, April 4, postoperative oblique cystourethrogram.

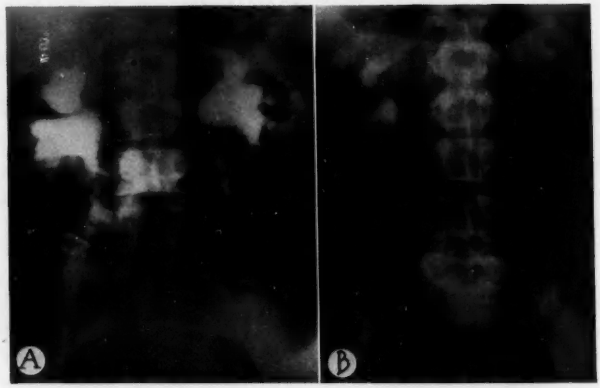

FIG. 3. Case 1, J. H. Excretory pyelograms. *A*, February 22, 1956, preoperatively. *B*, June 20, three months postoperatively.

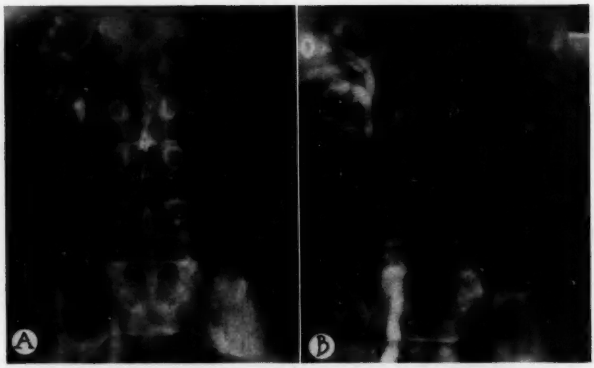

FIG. 4. Case 7, J. S. Excretory pyelograms. *A*, July 18, 1956, preoperatively. *B*, January 30, 1957, 4 months postoperatively.

3) *Ureteric reflux*. Four cases had unilateral reflux preoperatively, and in only two was this abolished. In one case, backflow was first demonstrated after the resection.

4) *Hydronephrosis*. In two cases with pre-existing hydronephrosis, the pyelograms had reverted to normal four and six months postoperatively, there having been no vesical drainage in the interim (figs. 3 and 4).

5) *Infection*. In only one case did the urine become sterile, but in at least two others the infection diminished noticeably.

The degree of stress incontinence which these patients experience is similar to that found in the average cauda equina lesion, and they find it necessary to wear a urinal for special occasions, and often at night as well. In no case has there developed continuous dribbling from an empty bladder.

CONCLUSIONS

Resection of the nonspastic external urethral sphincter seems to be effective in relieving the obstruction without increasing to any serious degree the risk of incontinence. It is probably a dangerous procedure (as, indeed, are other urological operations) in cases with severe infection resistant to antibiotics, and in those with bilateral hydronephrosis, especially in the presence of reflux. In these unfavorable circumstances, it may be safer to persevere with a perineal approach. However, in our more recent cases, we have been much more successful in preventing or clearing up preoperative infection, by employing the fine plastic catheters which we have been developing for several years. (Ross, Damanski and Gibbon 1957). We also revert to the use of these catheters as soon as possible after the operation, and we feel that they greatly diminish the risk of surgery in these difficult cases, by minimizing the inevitable urethritis.

It is possible, moreover, that this operation may find a place in the treatment of the spastic external sphincter, as it does not produce the impotence which inevitably follows subarachnoid alcohol block or pudendal neurectomy. Comarr (1957) has already reported two such cases treated successfully in this way. The merits of transurethral resection for this purpose must, however, be compared with those of electrocoagulation of the sphincter (Baumrucker 1948) and urethrolysis (Semans 1950). The latter operation was conceived by its author as a form of peripheral denervation of the sphincter, but the incontinence produced seems more severe than would be expected on such a basis. Some modification might be worth a trial.

Further reports of the effects of various procedures in the difficult type of case considered in this paper are urgently required to clarify the indications for resection of the external sphincter.

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MR. GIBBON (Liverpool, England): I am very grateful to you, Dr. Emmett, and to your association for your kind invitation to be here at this meeting. I regard it as a great honor to tell you on behalf of Mr. Cosbie Ross and Mr. Damanski of some of our recent experiences in the Liverpool Regional Paraplegic Center.

As a general surgeon, I felt a little bit difficult about addressing this august gathering, but I must say that some of Dr. Prather's quotations have given me heart.

I would like to amplify on what Mr. Riches said with regard to the smaller towns in Britain, in which there was no full-time department of urology. It was

nice of him to say so, but they include Liverpool with a little over 100,000 inhabitants.

We feel that in the interests of the patient the separation of urology will in the future be inevitable.

MODERATOR EMMETT: Thank you, Mr. Gibbon. I could not help wondering during that presentation how many partial resections of the external sphincter I may have done inadvertently on cord bladders.

Dr. Bunts will now discuss the "Treatment of Vesicoureteral Reflux in Cord Bladder." Dr. Bunts, we know most of your experience is with acquired lesions. If you have anything to say about this condition in children with myelodysplasia, we will appreciate it.

DR. BUNTS: Dr. Emmett, in reply to your question, we have recently, as you probably know, made a survey and tried to evaluate the results of vesicoureteroplasty performed by various surgeons throughout the country. In our Mid-Atlantic Section we have recently given a report. Our results have not been quite as good. Our paper has been combined with Dr. Hutch's. The over-all survey, I think, showed our percentage of success as being around 70 per cent. It will appear in print in a few months.

VESICOURETERAL REFLUX IN PARAPLEGIC PATIENTS

R. CARL BUNTS

From the Urological Section, Surgical Service, McGuire Veterans Administration Hospital, Richmond, Va.

The most formidable of all urinary tract complications in 1000 paraplegics treated by us since April 1946 has been vesicoureteral reflux. In 136 (13.6 per cent) reflux of clinical significance has developed.

ETIOLOGY

Considerable controversy exists as to the mechanism of the development of reflux in the paraplegic. It has been stated that the reflux which develops is the direct result of interruption of the ureteral nerve supply. We do not agree with this theory for the following reasons:

1) Failure of the majority of patients with corresponding neurological lesions to acquire reflux.

2) The unilateral incidence in some instances although the spinal transection is complete.

3) The occasional remission or improvement.

4) No normal nerve connections with the central nervous system have as yet been demonstrated, the interruption of which will cause reflux.

5) The excised bladder or the bladder in the cadaver may be filled to the point of rupture without reflux taking place.

Obstruction at or below the bladder neck is not a primary factor in the formation of reflux in these patients (although we have noted reflux with the same anatomical changes in or near the ureteral meatus in the patient with bladder neck obstruction). Practically all paraplegic patients have free, uninterrupted drainage either by suprapubic tube or urethral catheter.

It is our opinion that the reflux which develops in the cord injury patient is the result of anatomical changes in or near the vesicoureteral orifice. These changes are indirectly associated with cord injury and probably result from erratic nervous impulses originating in the distal stump of the spinal cord causing the bladder to become contracted and trabeculated. The complications that accompany cord injury such as bladder stones and prolonged cystitis are probably also a factor in the development of reflux. In support of our theory are the following:

Disappearance occasionally of the reflux when the caliber and degree of trabeculation of the bladder are lessened. This has been noted after the subsidence of a very severe cystitis or removal of bladder calculi. In 20 per cent of our patients the reflux disappeared with catheter drainage. Secondly, the conversion of an upper motor neuron lesion to a lower motor neuron lesion by subarachnoid alcohol injection has resulted in the elimination of hydroureter and nephrosis and reflux. As first suggested by Graves and Davidoff and repeatedly stated by Emmett and us, a prerequisite for the development of reflux in all but the rare case is that there be "a sustained tonus of the bladder as it actively resists filling,"

coupled with a diminished sensitivity of the bladder to fill and stimuli. In 1952 in my discussion of a paper by Drs. Brendler, Dean and others, in which they described their experiences with rhizotomy in the treatment of the advanced paraplegic bladder, they noted marked improvement in the dilated upper urinary tract in three of four patients. At that time I reported the loss of reflux in 2 patients following subarachnoid alcohol injection. Hutch in 1956 reported the loss of reflux in one patient and improvement in the degree of hydronephrosis and hydroureter in three others by elimination of the sacral reflex arc. This slide* is that of a patient in whom mild reflux and hydroureter and nephrosis developed in his remaining right kidney; the 30-minute excretory urogram to your right was made 5 days following subarachnoid alcohol injection and shows much improvement.

Within the past 2 months we have carried out subarachnoid alcohol injection in 2 patients and sacral rhizotomy in one patient (S_2, S_3, S_4) who had reflux and hydroureter and nephrosis. All have improvement in the degree of dilatation of the upper urinary tract.

This is an excretory urogram of a patient with nonobstructive hydronephrosis on the left, which showed marked improvement 9 days following subarachnoid alcohol injection.

This is a pre- and a post subarachnoid injection cystogram in the same patient showing decrease in the degree of reflux. We believe that this is further evidence that the same forces are at play in nonobstructive hydronephrosis with or without reflux.

There is a possibility that the reflux may be completely eliminated in these two patients in time. In the patients reported by Hutch, optimum improvement was found only after the elapse of 6 to 21 months. Permanent reflux has not developed in any of our patients with a complete lower motor neuron lesion and atonic bladder.

Further evidence in support of our hypothesis is x-ray evidence of a diverticulum or cellule in or near the ureteral meatus which results in loss of support behind the intramural ureter, there no longer being firm bladder musculature behind the ureter for it to be compressed against by inward intravesical pressure. Study of 136 cystograms showing reflux revealed a small diverticulum or cellule to be present in the region of the vesicoureteral opening in 65 per cent.

Cystoscopic examination confirmed the x-ray findings. The small diverticulum was found to lie above and lateral to the ureteral orifice. When a ureteral catheter is passed through the ureteral orifice, it will outline the ureter passing under the floor of the saccule. All had trabeculation of the bladder.

Another finding in those patients with a well developed saccule was displacement and loss of obliquity of the intramural ureter which retains its caliber although the ureter is dilated above the portion.

A photomicrograph taken from the BULLETIN OF THE JOHNS HOPKINS HOSPITAL of 1903 depicts a sagittal section of the normal vesicoureteral junction and the distortion that results from the presence of a diverticulum in this region.

* Reproduction of slides will not be made.

It is noted that the intramural ureter has assumed an extravesical position with a loss of its obliquity and muscular support beneath.

This schematic drawing of the vesicoureteral junction depicts what probably occurs when the vesical wall behind the intramural ureter is weakened. Point X where the ureter normally enters the bladder is now found to lie a few millimeters to a centimeter beyond the outer bladder wall.

Obstruction, either functional or mechanical, is probably always present with and almost always precedes reflux. In observations made on our cystograms with and without reflux it was noted in a high percentage of the x-rays that there was a sudden interruption of the contrast material in the ureter a few millimeters to a centimeter before it entered the bladder wall. This area had all the appearances of a strictured area but it has been found that large caliber ureteral catheters and bulbs will pass this point with ease.

The intramural ureter has no circular fibers and is unable to propel the urine through the bladder wall and acts only as a conduit and then only if it is supported by Waldeyer's sheath and a firm bladder wall behind it. When sacculation occurs the intramural ureter becomes extravesical losing its normal support. Having no propulsive force of its own and with a loss of support, the intramural ureter now acts as an obstruction. It is known that the intramural and intravesical ureter has no circular fibers and that dilatation of the ureter must involve weakening of the circular fibers as noted in the ureter above the bladder.

The hydronephrosis and hydroureter found in reflux may also result from a mechanical obstruction due to acute angulation of the displaced extravesical ureter.

TREATMENT

After several unsuccessful attempts to alleviate reflux by simple reimplantation of the ureter, an operative procedure was devised at our hospital which has three principles: First, the attachment of the ureter to the trigone is preserved; second, a long intravesical ureter is constructed; and third, the bladder wall behind the ureter is reinforced.

Thirty-one cord injury patients have had repairs of vesicoureteral reflux. In 11 the reflux was unilateral and in 20 bilateral. In 38 ureters the procedure was successful and 13 were failures.

We have found that the recurrence of reflux in our patients has occurred immediately (5 ureters) following repair or several months afterwards (3 ureters). On cystoscopic inspection of the patient in whom recurrence is immediate, it is noted that the ureter has retracted to its original bed. We believe this may be due to faulty technique at the time of the operative procedure and may result from incomplete mobilization of the lower one-third of the ureter. The ureter should be dissected free so that it may adjust to its new course through the bladder wall without tension and will not retract to its former position.

In those patients who have a delayed recurrence, we feel that there has been a failure to eliminate the factors which caused the reflux.

Obstruction, by far the more serious complication, may be partial and tempo-

rary as seen in three ureters of our series. We attribute temporary obstruction to postoperative edema or tight suturing around the ureter at its exit from the bladder. Permanent ureteral obstruction may vary from a slight increase in dilatation of the lower ureter to complete obstruction. In analyzing our patients who have acquired permanent obstruction, we believe that the ureter was not allowed to pass through the bladder wall loosely and without tension or angulation over the area from which it was dissected. Acute angulation results from tight suturing beneath the intravesical ureter near its exit combined with improper fixation sutures, as depicted in this slide.

In one of our patients, an intraureteric fibrous band formed between the newly created intravesical ureters producing an acute medial angulation. Resection of this band resulted in the immediate retraction of the nipples to a lateral position, thus relieving the obstruction.

COMMENT

Vesicoureteral reflux in the paraplegic is the result of anatomical changes in or near the intramural ureter produced by factors which cause a sustained hypertonicity of the bladder. In the paraplegic, this hypertonicity is probably due to the continuous bombardment of the bladder by impulses originating from the isolated sacral reflex centers.

Possibly in the future, if we are able to determine the precise pathogenesis and are successful in eliminating the cause of reflux in the paraplegic in its incipiency, by denervation of the bladder, vesicoureteral plasty will then only be necessary in the patient who acquires irreversible reflux.

CONSERVATIVE MANAGEMENT OF NEUROGENIC BLADDER, INCLUDING RE-EXPLORATION OF THE SPINAL CORD

JOHN K. LATTIMER

From the Squier Urological Clinic and Presbyterian Hospital, New York 32, N. Y.

I shall discuss a few points on the conservative management of neurogenic disturbances of the bladder, including re-exploration of the spinal cord, when the degree of disability of the urinary tract is so slight that the disability may be reversible. In this category, most of the patients whom we can help will be children in whom the imbalance between the power of the detrusor musculature and the resistance of the neck of the bladder is very slight. In this group of patients, conservative measures may suffice to reduce the resistance of the neck of the bladder.

We have seen many children with greatly dilated urinary bladders, but only moderate hydronephrosis. After repeated dilatations of the urethras, the sizes of the bladders became normal, and the hydronephroses disappeared. These reversible conditions represent very minor degrees of urologic imbalance. Nevertheless, they are the types of conditions in which conservative treatment may be effective.

Long-term drug therapy with cholinergic medications has not been a practical therapeutic measure, at least in our hands.

We have also seen a group of patients with a severe degree of dilatation of the urinary tract resulting from spina bifida which has been permitted to remain untreated for years. The tracts of these children, in spite of resection of the vesical neck, often are so severely dilated that they cannot empty well at a single voiding. In these children, satisfactory emptying often can be achieved by "triple" voiding. In addition to voiding three times at intervals of 1 minute, we ask the parents to get these patients up at night and see that they void twice. These maneuvers are helpful in reducing residual urine.

We have had a small group of children, reported upon to you last year, who had undergone surgical repair of meningocele at birth, but in whom the lower end of the spinal cord had become caught in adhesions at the level of the sacral repair. Our neurosurgeon, Dr. James Campbell, reoperated upon these children, who, over the next 5 to 10 years after the surgical repair of a meningocele at birth, gradually began to exhibit progressive signs of neurogenic bladder. He then liberated the adhesions which held the cord bound down to the sacrum. When these adhesions are released, the spinal cord often can be seen to spring upward, and the sacral nerve roots, which should have been running up to the region of the twelfth thoracic vertebra before joining the conus medullaris, are able to resume a more nearly normal course. Dr. Campbell has helped several such patients. Here is a specific situation in which we were able to do some good by a neurosurgical procedure. The overdilated bladders often did not empty at a single voiding, but did do so at the third voiding of the triple-voiding program.

In some cases, of course, in spite of the release of the spinal cord and adhesions, the results may not be satisfactory because of incomplete liberation of adhesions. In such cases it may be necessary to carry out surgical re-exploration of the spinal canal in an effort to release the cord further. In this specific type of case, neurosurgery can be a very great help.

SURGICAL PROCEDURES ON THE VESICAL NECK

EDGAR BURNS AND W. E. KITTREDGE

From the Department of Urology, Ochsner Clinic, New Orleans, La.

No clinical urologic condition requires more deliberate consideration in the planning of its management than vesical dysfunction due to spina bifida. One is attempting to convert a lesion that is physically disabling and socially incompatible into one that will permit a reasonable degree of physical well being and allow the individual to live in a fairly normal environment.

The objectives in the treatment of vesical dysfunction due to spina bifida are to restore urinary control, eliminate residual urine, preserve renal function and eliminate infection of the urinary tract. In trying to achieve these objectives one attempts to substitute mechanical procedures for a normal nerve supply that will enable the lower urinary tract to perform some semblance of normal function.

It should be recognized that an ideal result will not be obtained and that one must proceed from one step to another in an effort to find the best possible solution to the problem involved in each individual case. The degree of maldevelopment is extremely variable, and therein lies the explanation for an improved situation after treatment in some patients and the reason for failure in others.

Each individual must therefore be subjected to most careful neurologic and urologic evaluations. The findings in the urologic examination of these patients differ from those in acquired lesions of the spinal cord and simple congenital obstructive lesions of the vesical neck in that in the majority of cases the external sphincter is of decreased tone and is incompetent. The degree of incontinence will vary from one individual to another. Some patients will have total incontinence of urine, others almost complete retention, and still others will have both residual and dribbling.

The amount of residual urine is probably the best index to the degree of imbalance between the detrusor muscle and the vesical outlet. Accuracy in determining the amount of residual urine is important in selection of the method of management. Young[1] suggested that "ascendent" lipiodol is a somewhat more rigid criterion for measuring residual urine than is catheterization. Those without residuals should retain no lipiodol at the end of 24 hours. In the management of these patients the residual urine must be eliminated in order to protect the integrity of the upper urinary tract and permit sterilization of the urine.

Five surgical procedures may be used in the treatment of vesical dysfunction that results from spina bifida. They are transurethral resection, retropubic Y-V plasty with posterior wedge resection, the Millin sling operation, the Kelly or some similar type of urethroplasty, and complete closure of the vesical neck with permanent suprapubic drainage. Because of the variability of the lesion,

[1] Young, B. W., Anderson, W. L. and King, G. G.: Radiographic estimation of residual urine in children. J. Urol., **75**: 263–272, 1956.

the application of any method of management to an individual problem is highly selective, and many failures will be encountered. In patients in whom all other procedures have been unsuccessful, construction of a substitute bladder from an isolated intestinal segment should be considered.

TRANSURETHRAL RESECTION

In patients who have residual urine, transurethral resection of the vesical neck is perhaps the most effective means of establishing a balance between the strength of the detrusor muscle and the resistance of the vesical outlet. In the application of transurethral resection to this group of patients, age and sex must be considered. The size of the urethra in boys less than five years of age limits the size of the instrument that can be used and therefore the adequacy of the procedure itself. Emmett and associates[2] suggested that it is best not to try transurethral resection in boys less than two years of age. In this group they recommended suprapubic cystostomy to protect the integrity of the upper urinary tract, and appropriate use of perineal urethrostomy in boys older than this in an effort to prevent urethral stricture.

Transurethral resection of this type of lesion is a more meticulous procedure than transurethral resection of simple non-neurogenic congenital obstructive lesions. The landmarks are not clearly defined. The entire circumference of the urethra should be resected from the internal vesical orifice to the verumontanum, and it is better to remove too little tissue than too much. Most of our patients have required two resections and some three or more. The operation should be repeated as soon as it can be established that residual urine is still present. If as much tissue as possible has been removed from the prostatic urethra, and the patient still has residual urine, resection of the proximal margins of the external sphincter is justified provided one recognizes the narrow margin between residual urine and total incontinence.

The female urethra lends itself well to urethral dilatation, which will permit earlier performance of transurethral resection with little likelihood of the subsequent development of urethral stricture. Our experience in the management of a large group of non-neurogenic obstructive lesions in females is that in patients older than five years the urethra can usually be sufficiently dilated to permit use of an adult type of instrument. The danger of development of urethrovaginal and vesicovaginal fistulas is recognized and the amount of tissue that can be safely removed from five to seven o'clock is limited. More liberty may be exercised in the remainder of the circumference, and the posterior third of the urethra may be safely resected. By use of transurethral resection it should be possible to eliminate residual urine in this group of patients.

THE OPEN RETROPUBIC APPROACH

The difficulty in removing an adequate amount of tissue transurethrally in children of both sexes younger than five years of age has led us to use an open approach with increasing frequency during the past 12 years. Enough patients

[2] Emmett, J. L. and Simon, H. B.: Transurethral resection in infants and children for congenital obstruction of the vesical neck and myelodysplasia. J. Urol., **76:** 595–608, 1956.

with neurogenic and non-neurogenic lesions have now been followed for a sufficient period of time to evaluate postoperative results. In operating upon the neurogenic lesions one is faced with the same problem that exists in the performance of transurethral resection, that is, the entire circumference of the posterior urethra must be included. Posterior wedge resection alone did not prove satisfactory. After the first report of Young[3] of his modification of the open procedure we started adding it to the posterior wedge resection. His Y-V plasty is now being used instead of the original longitudinal incision and transverse closure. This has resulted in considerable improvement of the results obtained in the non-neurogenic cases. It has been our experience, as well as that of others, that not enough tissue can be removed from the distal portion of the posterior urethra to eliminate residual urine in many cases. It has the advantage, however, that it can be performed on children in the age group in which Emmett recommends suprapubic cystostomy. Suprapubic cystostomy drainage may be continued and supplementary transurethral resection can be performed when the child is older if removal of more tissue is indicated.

Two complications may occur during performance of the open operation. One is vesicovaginal or urethrovaginal fistula in females and the other is urinary incontinence from extension of the longitudinal incision too far distally in both sexes. An apical stitch should always be inserted but this does not offer absolute protection against development of this latter complication. Young[4] suggested that incontinence may occur from tenting of the external sphincter by a longitudinal incision and transverse closure. His experience with the procedure in the neurogenic group parallels that of others in that the results are less satisfactory than in non-neurogenic cases.

THE MILLIN SLING OPERATION

We have tried to rationalize use of the sling operation in the management of vesical dysfunction due to spina bifida. It is contraindicated in patients with residual urine. In those with a relaxed external sphincter and no residual urine, it would appear to create an imbalance by increasing the resistance at the vesical outlet. This has been borne out by the postoperative course of some of our patients who have had the sling operation. An example of this is the case of a girl, five years old, on whom the operation was performed in August 1955. Although she has been able to keep reasonably dry, the intravesical pressure has been sufficiently increased to produce left vesicoureteral reflux. The sling operation has been shown to produce enough obstruction at the vesical neck in non-neurogenic cases to cause decompensation of the upper urinary tract, and its use in the neurogenic group should be contraindicated.

PLASTIC PROCEDURES ON THE URETHRA

In patients with total incontinence of urine a Kelly type of urethroplasty may be performed to support the action of the external sphincter and improve

[3] Young, B. W.: Retropubic approach to vesical neck obstruction in children. Surg., Gynec. & Obst., **96:** 150–154, 1953.
[4] Young, B. W.: Personal communication to the authors.

control. This procedure should be reserved for the older girls, in whom the operation is easier to perform than in younger girls. A surprising amount of working space can be obtained by performance of a liberal episiotomy. An occasionally satisfactory result may be obtained from this procedure but the difficulty lies in securing enough support to prevent dribbling without increasing resistance at the vesical outlet sufficient to contribute to damage of the upper urinary tract. Patients treated by either of these latter procedures must be carefully followed.

CLOSURE OF THE BLADDER NECK

Gross and associates[5] favored complete closure of the vesical orifice with permanent suprapubic cystostomy drainage only after all other methods have failed. The frequency of failures from other methods and the infrequent use of this procedure suggest that it should be utilized more often than it is. The catheter may be attached to a small collecting bag or clamped and opened at intervals. These patients are usually able to enjoy a reasonable degree of activity. Everyone is familiar with the complications of continuous suprapubic drainage but good management should reduce these to a minimum. Construction of a substitute bladder from an isolated intestinal segment is being evaluated in a number of medical centers and may prove to be a method of choice in the management of many of these cases.

SUMMARY

The variable results of the surgical treatment of vesical dysfunction due to spina bifida are evidence that there is no standard method of managemenf of all cases. There are five surgical procedures that may be performed on the dysfunctioning vesical neck due to spina bifida in an attempt to eliminate residual urine: transurethral resection, retropubic Y-V plasty with posterior wedge resection, the Millin sling operation, the Kelly or some similar type of urethroplasty, and complete closure of the vesical neck with permanent suprapubic drainage. Of these, transurethral resection has been found to be the most satisfactory. Operations that increase the resistance at the vesical outlet are contraindicated.

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[5] Gross, R. E., Holcombe, G. W., Jr. and Swan, Henry: Treatment of neurogenic urinary and fecal incontinence in children. A. M. A. Arch. Surg., **66**: 143–154, 1953.

DIVERSION OF URINE IN CORD BLADDER

REED M. NESBIT

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Among certain patients suffering from neurologic disease of the bladder suprapubic drainage or drainage by catheter fails, for one reason or another, to prove entirely satisfactory. I refer to those patients who do not have satisfactory automatic urination, and who must therefore be provided with some form of drainage.

Specifically, I would refer to two types of patients. First is the patient in whom a spastic bladder has developed, with secondary obstruction of the intramural ureter and resultant hydro-ureters and infection. I know that the condition of many such patients can be improved by rhizotomy, but this is not invariably true.

I have in mind a very few instances in which the patient, because of a highly spastic reflex bladder, was not able to manage himself with any type of automatic urination. Bilateral hydroureters developed which enlarged progressively and became septic, and the condition of the patient deteriorated rapidly in spite of all efforts that were made to control his infection. In desperation, we decided to establish supravesical diversion of urine, and hence transplanted his ureters into a segment of the ileum that was brought to the skin. This was the first patient with neurologic bladder treated in our hospital in this manner. He made a prompt recovery and his ureters returned to normal size. He has continued to do very well now for about 4 years, and the result obtained for him of course is of great satisfaction to us.

Three or four other patients have been in exactly the same situation, and have been treated similarly, mostly with good success clinically. Still, two of them have not become well adjusted to the arrangement, since the two in question actually were more comfortable while drainage by catheter was being used, and were not particularly concerned if sepsis was present occasionally. They believe their present arrangement is more bothersome than the arrangement they had before. I believe it is worth while to comment upon the psychologic status of these patients, because not all patients who have undergone supravesical diversion of the urine, with the use of ileal conduit, appear to be entirely happy about it after it has been done, even though it may seem to be a lifesaving procedure.

One of the most satisfactory applications of this type of supravesical diversion has been in the treatment of the little children who have meningomyelocele and who have total incontinence. We have all observed such patients, and our hearts go out to them because they have continual leakage of urine, and cannot be trained. Some of them are incontinent, even in the presence of empty bladders, and some of them have varying amounts of residual urine.

Yet I am certain that some of these children, if they have good sphincter tone, can be educated, and many can be improved by endoscopic resection. The ones who constitute heartbreaking problems are those who seem to lack any sphincter

tonicity. Indeed, some of them have such lack of sphincter tone that they are incontinent even when a Foley catheter balloon of large size is left in the bladder in an effort to tamponade the outlet.

We have treated some of these children (mostly females) by transplanting the ureters into a segment of ileum, and have been greatly pleased with the end results. In fact, our neurosurgical colleagues feel that such a procedure is one of the greatest advances thus far made in the management of this type of condition. However, regardless of the advantages inherent in this procedure in these cases, I again wish to emphasize the necessity of proper mental preparation of the patient for the procedure.

I can best illustrate what I am talking about by an incident that occurred not long ago. At the urgent request of our neurosurgeon, we performed this operation on a child who was totally incontinent but who hardly realized what was going on. She was rather young, and of subnormal mental status. She has not adapted herself at all to the new arrangement, and the soiling now is just about as bad as it was previously.

By contrast, the first of these children on whom we did the operation was a highly intelligent child of about 8 years who was keenly aware of the stigma and the ostracism that attended her difficulty. When the operation was explained to her she was eager to have it done, and afterward was a most co-operative and happy child. The results gave her a freedom of activity that she had never before enjoyed, and it permitted her to move freely among her little colleagues with complete acceptance.

Her enthusiasm about the new state of affairs was reflected only a few weeks ago when another child, 9 years old, similarly afflicted but from another city in Michigan, came to us with her parents and asked to have the operation performed. She had heard about the transformation that had taken place in the other little girl. Word had gone to her by some devious grapevine. I need not tell you that this second child was a perfect patient, that she co-operated in every way after the operation, and that she had an eager desire to teach herself how to accommodate the change that would keep her entirely free from being soiled.

I feel that there is a very definite place for supravesical diversion, with use of the ileum as a conduit for urine, in certain selected cases in which there is a neurologic background. Nonetheless, I wish to urge that all surgeons who contemplate performance of the operation in this type of case prepare their patients mentally and emotionally for the altered status that it brings about.

URINARY DIVERSION

JUSTIN J. CORDONNIER

From the Division of Urology, Department of Surgery, Washington University School of Medicine, St. Louis, Mo.

Certain cases of myelodysplasia of the urinary bladder secondary to spina bifida in childhood require urinary diversion. All other methods of bladder management should be attempted prior to the adoption of any permanent type of urinary diversion. On the other hand, many of these children are totally incontinent and in many instances there is progressive upper urinary tract disease, secondary to ureterovesical reflux and repeated pyelonephritis.

In our experience, permanent urinary drainage by means of a suprapubic cystostomy has many disadvantages. In the first place, a drainage tube of some sort is required. This is undesirable for two reasons: first, the necessity of change of tube once monthly and secondly, the maintenance of persistent urinary tract infection.

Recently we have used a method which we feel is satisfactory. This method consists of anastomosing an isolated loop of ileum in an isoperistaltic fashion to the remaining portion of the bladder, the bulk of the bladder having been resected. The advantages of this method over permanent cystostomy are ease of collection of urine and elimination of suprapubic tube. The technique of this procedure is being described in another publication. The success of the procedure depends upon the patency of the ureterovesical junction. The principal advantage over the conventional ileal segment is that one source of error, namely reimplantation of the ureters into the segment, is eliminated.

This procedure has been utilized on 5 children, 3 of whom have been followed for a period in excess of one year. We have been thoroughly satisfied with the results obtained to date.